EAST ANGLIAN ARCHAEOLOGY

Experimental Archaeology and Fire: the investigation of a burnt reconstruction at West Stow Anglo-Saxon Village

by Jess Tipper

with contributions by
Rachel Ballantyne, Gill Campbell, Vanessa Fell, Charles French, Karl Harrison, Harry Kenward and Karen Milek

principal illustrations by
Crane Begg

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Cover illustration:
The Farmer's House during the final dramatic stages of the fire that destroyed it in February 2005 (*courtesy of St Edmundsbury Borough Council*)

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Summary

The destruction by fire of a reconstruction of a Sunken-Featured Building (SFB or *Grubenhaus*) at West Stow Anglo-Saxon Village, Suffolk, presented a unique opportunity for experimental archaeology, and provides new insight into the nature of burnt buildings in the archaeological record. It also provides an opportunity to understand better the structural form of this distinctive building type. The burnt remains of the reconstruction were meticulously excavated and recorded using conventional methods combined with a range of forensic fire investigation techniques, which has enabled the seat of the fire and sequence of destruction to be identified. The study has also enabled a range of standard scientific techniques to be tested because we know how and with what materials the building was constructed and also what and where objects were located within it when the fire occurred. The results are fully described and presented in this unique study, and the implications for our understanding of burnt remains are examined, providing a reference for future investigations of buildings destroyed by fire.

Résumé

La destruction par le feu d'une reconstruction de Sunken-Featured Building (SFB ou *Grubenhaus*) dans le village anglo-saxon de West Stow (Suffolk) a constitué une occasion unique de pratiquer une archéologie expérimentale et de mieux connaître la nature des bâtiments brûlés sur un plan archéologique. Cette étude nous a également permis de mieux comprendre la forme structurelle de ce type particulier de bâtiment. Les vestiges calcinés du bâtiment reconstruit ont été méticuleusement fouillés et enregistrés en combinant les méthodes conventionnelles avec un ensemble de techniques d'investigation utilisé par la police scientifique dans la recherche des causes des incendies. Il a ainsi été possible de déterminer le foyer de l'incendie et la

séquence de destruction du bâtiment. De plus, cette étude nous a permis de tester différentes techniques scientifiques standard. Nous savions en effet comment et avec quels matériaux le bâtiment avait été construit. Nous connaissions également la nature et l'emplacement des objets contenus dans le bâtiment au moment où l'incendie s'est déclaré. Cette étude unique contient une description complète des résultats obtenus. Les implications de notre compréhension des vestiges calcinés sont également examinées, ce qui constitue une référence pour de futures investigations concernant la destruction de bâtiments par le feu.

(Traduction: Didier Don)

Zusammenfassung

Die Inbrandsetzung eines rekonstruierten Grubenhauses im West Stow Anglo-Saxon Village in Suffolk bot die einmalige Gelegenheit für ein archäologisches Experiment, das neue Einblicke in die Beschaffenheit abgebrannter Gebäude im archäologischen Bestand liefert. Darüber hinaus trug das Experiment zum besseren Verständnis der Bauform dieses spezifischen Gebäudetyps bei. Die Brandreste des rekonstruierten Grubenhauses wurden fein säuberlich freigelegt und anhand konventioneller Verfahren, verbunden mit verschiedenen forensischen Methoden der Branduntersuchung, aufgezeichnet, was dazu führte, dass Entstehungsort und Ablauf des Brandes ermittelt werden konnten. Das Experiment erlaubte zudem die Überprüfung mehrerer wissenschaftlicher Standardverfahren, da bekannt war, wie und mit welchen Materialien das Gebäude errichtet worden war und welche Gegenstände sich wo in dem Bau befanden, als das Feuer auftrat. Die Ergebnisse dieser einzigartigen Untersuchung werden vollumfänglich beschrieben, zudem wird erörtert, wie sie sich auf unser Verständnis von Brandresten auswirken, wodurch ein Bezugspunkt für künftige Untersuchungen von abgebrannten Bauwerken geschaffen wird.

(Übersetzung: Gerlinde Krug)

1. Background and Circumstances

I. Introduction

West Stow is a site of international importance as one of the first large-scale investigations of an early Anglo-Saxon settlement in England, dating between the 5th to the early 8th centuries AD. Situated in the Breckland region of NW Suffolk, West Stow was excavated between 1965 and 1972 under the direction of Stanley West and funded by the Department of Environment (West 1985; Fig. 1.1). The site remains significant for the programme of experimental reconstructions[i] of Anglo-Saxon buildings, which have been built on the actual footings of Anglo-Saxon buildings using traditional tools and techniques and materials thought to have been used during the Anglo-Saxon period.

In February 2005, one of the experimental reconstructions of a Sunken-Featured Building (SFB), referred to as the Farmer's House, was destroyed by fire. Although it was not the result of a planned experiment or simulation, the unfortunate event provided a unique opportunity to assess the data preserved following a fire within a SFB and, in particular, it was the first reconstruction of its type, with a raised floor, to have been burnt.

The detailed investigation of the burnt remains was undertaken during July and August 2005, in a manner comparable to a conventional archaeological excavation. The evidence is described, discussed and illustrated in detail in this report. Using techniques of investigation generally applied in contemporary forensic fire scenes, an attempt has been made to understand the nature and dynamics of the fire and to identify the seat, and possibly the cause, of the fire. In addition, a suite of scientific techniques currently used to analyse archaeological deposits was employed to understand the remains and also to inform the use of these techniques, given that it is known when and how the building was constructed, what it contained and how it was destroyed. The information is compared with the archaeological remains of this building-type and used to inform the debate about the effect of fires relating to buildings in the archaeological record, specifically relating to the (re-) construction of SFBs, i.e. an aid to interpretation by comparative data.

II. The Anglo-Saxon settlement

The settlement at West Stow was situated on the N side of the River Lark and occupied a low knoll of sand *c*.1.80 hectares in extent and *c*.3.00m high, between 17.00–20.00m OD (TL 797 713). The Anglo-Saxon settlement, however, formed one phase of a multi-period site with evidence of activity from the Mesolithic to the late medieval period (West 1985 and 1990; Fig. 1.1). The total site plan shows a complex of intercutting features indicative of dense occupation on the knoll (West 1985, fig. 6).

The excavations were a turning point in the study of early Anglo-Saxon buildings, producing a group of 69 *Grubenhäuser* or sunken-featured buildings (SFBs) which, for the first time in England, were found in association with post-hole structures (Fig. 1.3). Stanley West referred to the seven largest post-built structures as 'halls' to 'demonstrate the essential function of these buildings, as the focal points of the family units' (West 1985, 112), because of their rarity in comparison to the number of SFBs and their alignment along the crest of the hill. He argued that the SFBs formed discrete groups around individual halls and suggested there were 'three main units of groupings of halls with attendant SFBs' (West 1985, 168). This arrangement continued throughout the occupation of the settlement, although there was 'movement on the site as buildings had to be replaced' (West 1985, 151 and fig. 301). There was no evidence of internal property boundaries, at least during the 5th to 7th centuries, and West argued that 'the loose groupings of the huts around the small 'halls' suggests the barest minimum of organization' (West 1969, 19). The ditched boundaries were developed during the latest phase of occupation, during the late 7th and/or early 8th century (see below), however these were irregular and did not clearly enclose particular groups of buildings.

At the time, Anglo-Saxon studies had been dominated by their way of death. The relatively limited knowledge of how Anglo-Saxons actually lived was based almost solely on E.T. Leeds' salvage excavations at Sutton Courtenay between 1921 and 1937, while the more recent excavations during the 1950s and early 1960s at the royal sites of Yeavering and Cheddar provided an understanding of the upper level of Anglo-Saxon society. The investigations at West Stow and also the contemporary excavations at Mucking (see below), in particular, during the second half of the 1960s, transformed our understanding of how the early Anglo-Saxons lived.

In the context of its contemporary landscape, the settlement at West Stow was probably typical, and one of a number of early Anglo-Saxon settlements, of varying sizes, along both sides of the river valley (Figs 1.1 and 1.2). A further five SFBs and one small post-hole building dating to the early Anglo-Saxon period, were discovered just *c*.130.00m to the E of West's excavation, in advance of the construction of a new museum store at West Stow in 2007 (Suffolk HER No. WSW 076; Gill and Goffin 2010). These were almost certainly part of a larger site, now destroyed by aggregate extraction and landfill, which continued E. To the W of West's excavation, there is an early Anglo-Saxon sherd scatter *c*.300m away (WSW 024) while two SFBs and one wall-post building were defined during rescue excavations at Lackford Bridge in 1980 (WSW 030), *c*.450m to the west (Tipper 2007). On the opposite bank of the river, *c*.450m to the S of West Stow, trial trenching in 1998 uncovered a single SFB and several pits (LKD 038) and distinctive sub-rectangular crop marks, defined by aerial reconnaissance, suggest further SFBs in this area; there is another scatter of early Anglo-

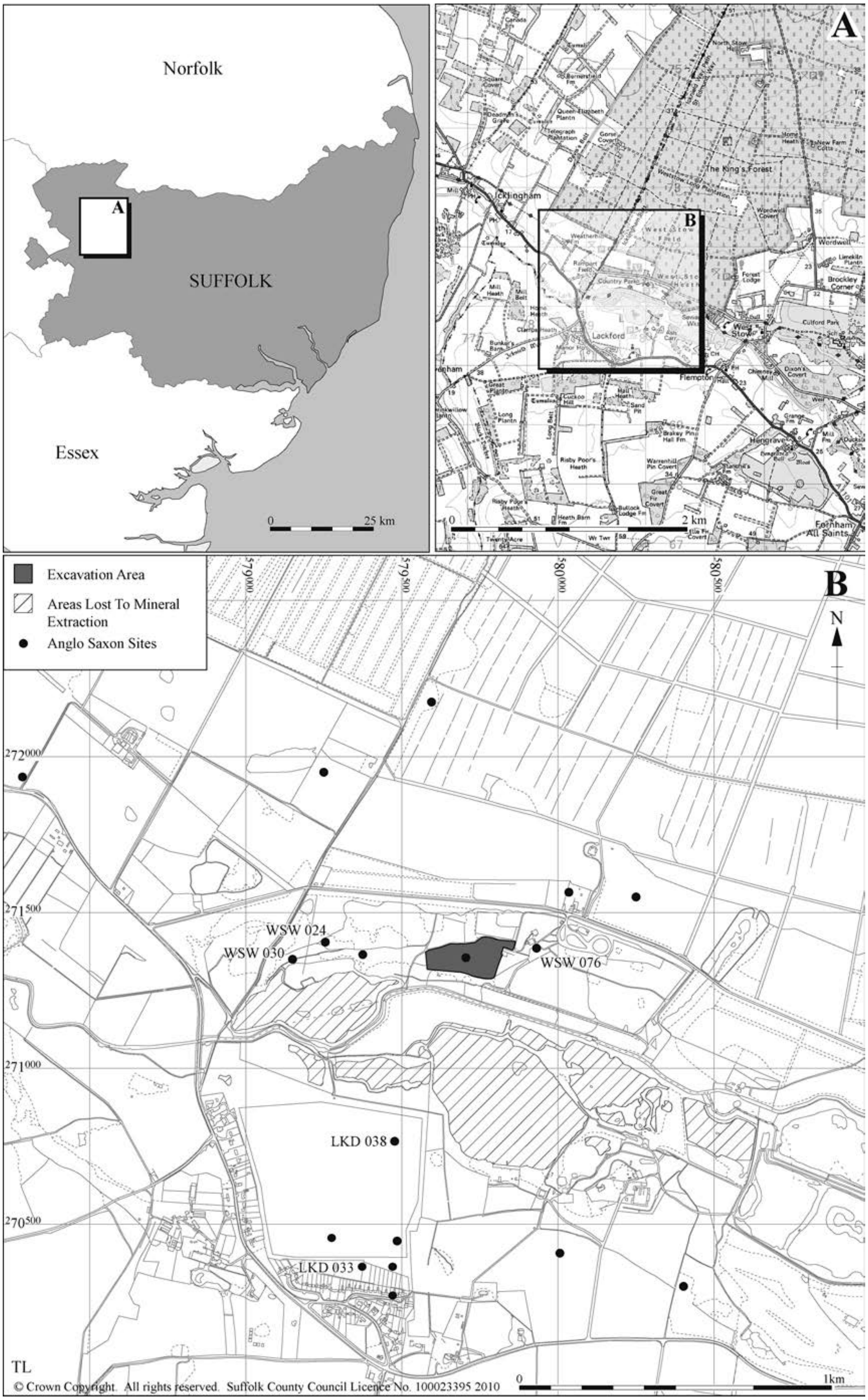


Figure 1.1 Location plan of West Stow, showing the extent of Stanley West's original excavations between 1965–72 (after West 1985, fig. 5). Early Anglo-Saxon sites and find spots recorded in the County Historic Environment Record are also marked in the immediate vicinity of the site; the labelled sites are discussed in the text. There is no differentiation between the types of evidence; dots on the map represent extensive sites as well as single find spots that might indicate further occupation features, or might simply be stray finds

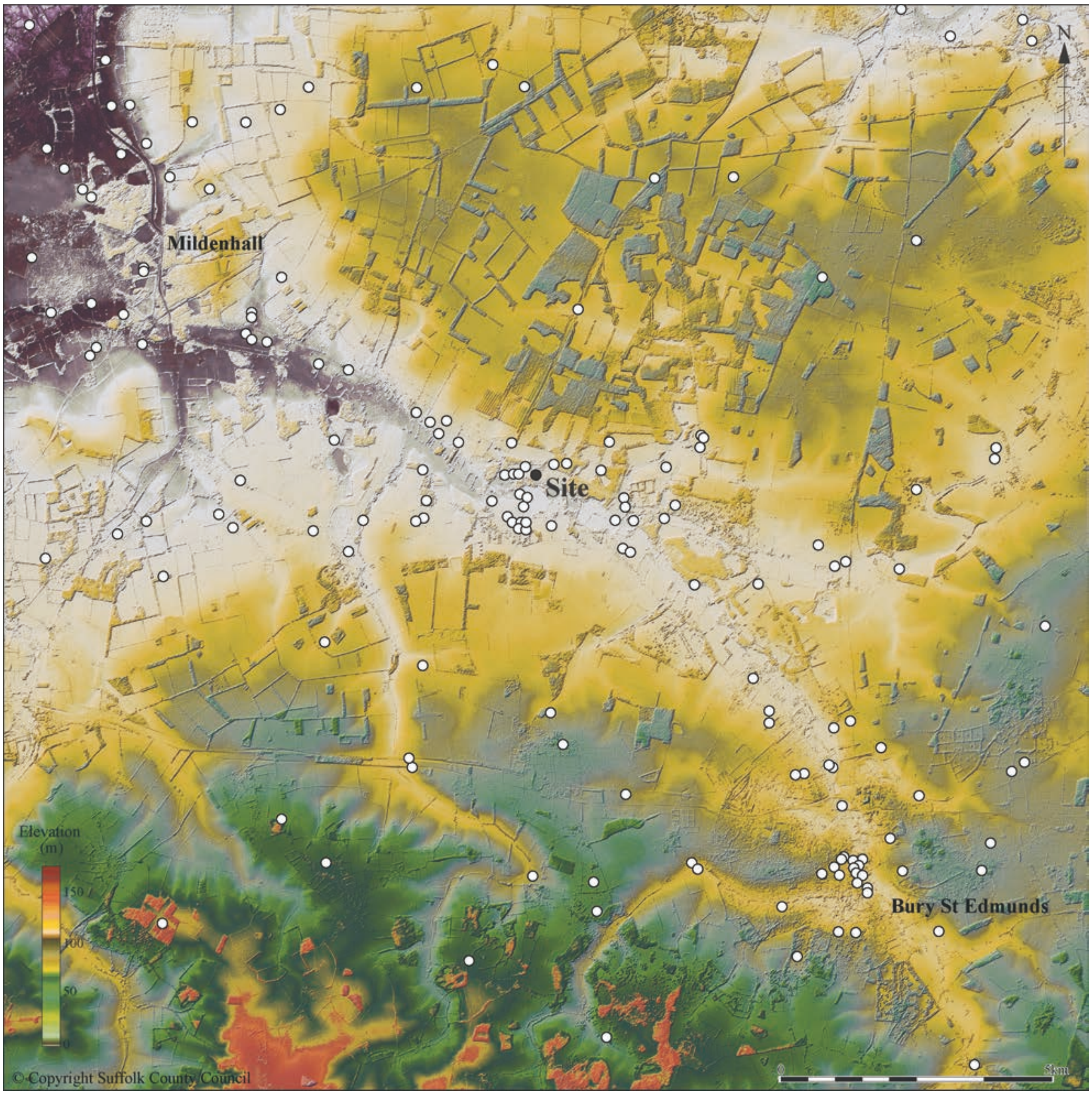


Figure 1.2 Early Anglo-Saxon sites and find spots recorded in the County Historic Environment Record in the central Lark valley. Again, there is no differentiation between the type of evidence and individual dots on the map represent known sites as well as single find spots of this period. The image is generated from IFSAR DSM5 (Interferometric Synthetic Aperture Radar, Digital Surface Model, 5.00m posting) creating a three-dimensional surface model

Saxon pottery to the south of this site (LKD 033). There is a more clearly defined settlement, shown by air photography, *c*.3.50km to the SE at Hengrave (HNV 001; SAM SF170). Almost certainly, there are more unrecorded settlements in the immediate vicinity, which have not been the subject of systematic investigation. The central Lark valley was probably a densely occupied landscape during this period as were most of the river valleys in Suffolk, suggested by a small number of investigated sites and, in particular, by a very large number of find spots and find scatters recovered by metal-detecting.

III. Sunken-Featured Buildings

The *Grubenhaus* or sunken-featured building is a distinctive building type that occurred in England mainly from the 5th to the late 7th centuries AD (although there are later examples) (Tipper 2004). From his investigations at Sutton Courtenay, E.T. Leeds had assumed that the inhabitants of these pit-dwellings lived in squalor 'amid a filthy litter of broken bones, of food and shattered pottery' (Leeds 1936); this view is echoed in other contemporary accounts of these features (see for example, Dunning 1932 and Lethbridge and Tebbutt 1933). At Mucking, a large-scale excavation that ran simultaneously, and sometimes seemingly in competition, with the investigations at West Stow, similar features were 'not regarded as anything but [the remains of] below-ground house floors', i.e. with the

Plate 1.1 Reconstruction of an SFB at West Stow as a traditional sunken-floored building (the Sunken House) with the roof sloping down to the ground surface, with the doorway at the E gable-end and with an internal sunken earth floor (viewed from E)

floor level on the base of the sunken feature (Jones 1983, 142; Hamerow 1993).

On the basis of the detailed structural, stratigraphic and finds evidence at West Stow, Stanley West put forward a new, and altogether different, interpretation of sunken-featured buildings as sophisticated and substantial ground-level buildings. He lifted the SFB 'out of the 'shed', 'outhouse' or 'dog kennel' class to a much more significant structure' (West 1985, 121), suggesting they had planked floors at ground level across the sunken feature or pit, which acted as storage space or as an air space, and with external vertical walls beyond the upper edge of the pit (West 1969; 1985). In marked contrast to their traditional reconstruction as sunken-floored buildings with the roof sloping down to the ground surface, his interpretation meant that the actual size of the buildings could have been much larger than the size of the pit (Plates 1.1 and 1.2).

The structural interpretation of SFBs has been one of the central issues in settlement studies during the last 30 years. Although their structural reconstruction with suspended floors has made a significant impact, and their interpretation at a number of other more recent excavations has followed West's interpretation, for example at Barrow Hills, Oxon., West Heslerton, North Yorkshire and at Bloodmoor Hill, Suffolk (Chambers and McAdam 2007; Powlesland forthcoming; Lucy *et al.* 2009), it has not been unanimously accepted and opinions are still divided between this and their traditional reconstruction as rudimentary sunken hut-dwellings (Hamerow 2002, 31). Welch, for example, has suggested that the charred boards defined on the base of SFB 15 at West Stow (see below) had not actually collapsed but were originally set on the base of the pit, forming a sunken and planked floor (Welch 1985, 23; 1992, 21–5).

The fills of the sunken features at West Stow generally contained two distinct fills. 'The lower one was a uniform, fine grey deposit; the upper one was a black layer, consistent in its nature with the occupation-layer covering the whole site' (West 1969, 8; 1985, 117–8). The lower fill, which ranged from a thin layer to one that entirely filled the sunken feature, was interpreted by West as a primary occupation deposit that had, in general, formed as a result of gradual accumulation below a suspended floor during the use of the original building. Based on this interpretation, the material within this layer was, therefore, directly related both to the function and the date of the building. The upper fill was interpreted as part of the general occupation layer (Layer 2), which accumulated in the hollows after buildings had been abandoned.

A detailed re-analysis of the deposits within sunken features at West Stow, and elsewhere in England, has cast doubt on West's interpretation (Tipper 2004, 103). Instead, it has been suggested that the lower fill was not necessarily the result of a single process such as material sifting between floor boards. Most of the material infilling sunken features was probably the result of tertiary deposition — essentially re-deposited rubbish from surface heaps, dumped in to the hollows after buildings had been abandoned and dismantled. With the exception of the two buildings destroyed by fire (see below), in which the contents of the buildings have been preserved on the base, the material in their fills has no direct association with the use of the original buildings. Their interpretation as suspended-floored buildings at West Stow, however, was not contested. Indeed, it was suggested that the majority of the evidence across the country points towards sunken-featured buildings with suspended floors (West 1985; Tipper 2004).

Plate 1.2 Reconstruction of an SFB at West Stow as a substantial ground-level building (the Weaving House), with a suspended floor over the sunken feature, vertical walls and with an internal area that is larger than the sunken feature (viewed from SE)

IV. The burnt remains of SFBs 3 and 15

Key evidence in their interpretation as suspended-floored buildings was the remains of two buildings that had burnt down (SFBs 3 and 15; West 1985, 119–20, figs 35 and 71; Figs 1.3–1.6). Both burnt buildings were located in the NE part of the site and both were phased by West to the late 6th or 7th century. Carbonised remains from the two buildings had been preserved in the sunken features, providing detailed information about the form of this building-type and significantly more information than most other investigated examples in this country. There were, however, no identifiable fragments of the frame, such as the ridge posts or the main structural beams (although small fragments in SFB 3 were interpreted as the remains of purlins or rafters), presumably because they had been completely destroyed. Also, there was no surviving surface remains around either of these features, with the exception of a small patch of burnt clay that partly overlaid the edge in the SW corner of SFB 15 that was interpreted as the remains of a small hearth. The evidence from each is set out in detail here, given its importance to the current work.

SFB 15

SFB 15 consisted of an E–W aligned sub-rectangular sunken feature, measuring 5.80 x 4.60m in area x 0.38m in depth. It was located in the NE part of the site, immediately to the N of Hollow 1 (Fig. 1.4). The sunken feature was interpreted as the remains of a two-post structure, as two large post-holes were located centrally along the E and W sides of the pit, *c*.4.95m apart. Both post-holes straddled the sides of the sunken feature, which sloped gradually down to a level base.

SFB 15 was one of two that burnt down which, according to West's interpretation, preserved the evidence of both planked floor and walls (West 1985, 119–20 and fig. 71; Fig. 1.5 and Plate 1.3). The remains of over ten charred planks, in two layers, were discovered lying directly on, or just above, the base of the sunken feature. These had a relatively orderly or parallel arrangement, generally aligned N–S across the width, and mainly in the N half, of the sunken feature. However, several of the lower charred planks on the NW side were aligned NW–SE.

At least nine charred planks measured over *c*.1.00m in length (based on the published plan). The longest surviving charred plank, on the E side of the sunken feature, measured *c*.2.20m. This plank sealed the E ridge post-hole and was itself sealed below a large deposit of loomweights. The surviving charred planks had a shallow concave profile, indicating an original plank thickness of at least *c*.0.06m (max.) and width of *c*.0.25m (max.) (West 1985, 20).

Five of the charred planks lying directly on the base of the sunken feature were sealed by quantities of fired, partially fired and also unfired clay loomweights (based on West 1985, fig. 71). A further six charred planks overlay the lowest layer of planks on the base of the pit, and at least two of these lay above the loomweights. According to the report, there were over 100 loomweights separating the two layers of planks (West 1985, 23 and table 59).

In total, West estimated there were *c*.170 loomweights from the fill of SFB 15. There were at least three distinct concentrations of loomweights on the base of the sunken feature, in the NE and SW corners and, more generally, in the NW part of the feature. There were over 100 loomweights in three groups located in the corners of the

Figure 1.3 Plan of the Anglo-Saxon settlement (after West 1985, figs 6 and 300)

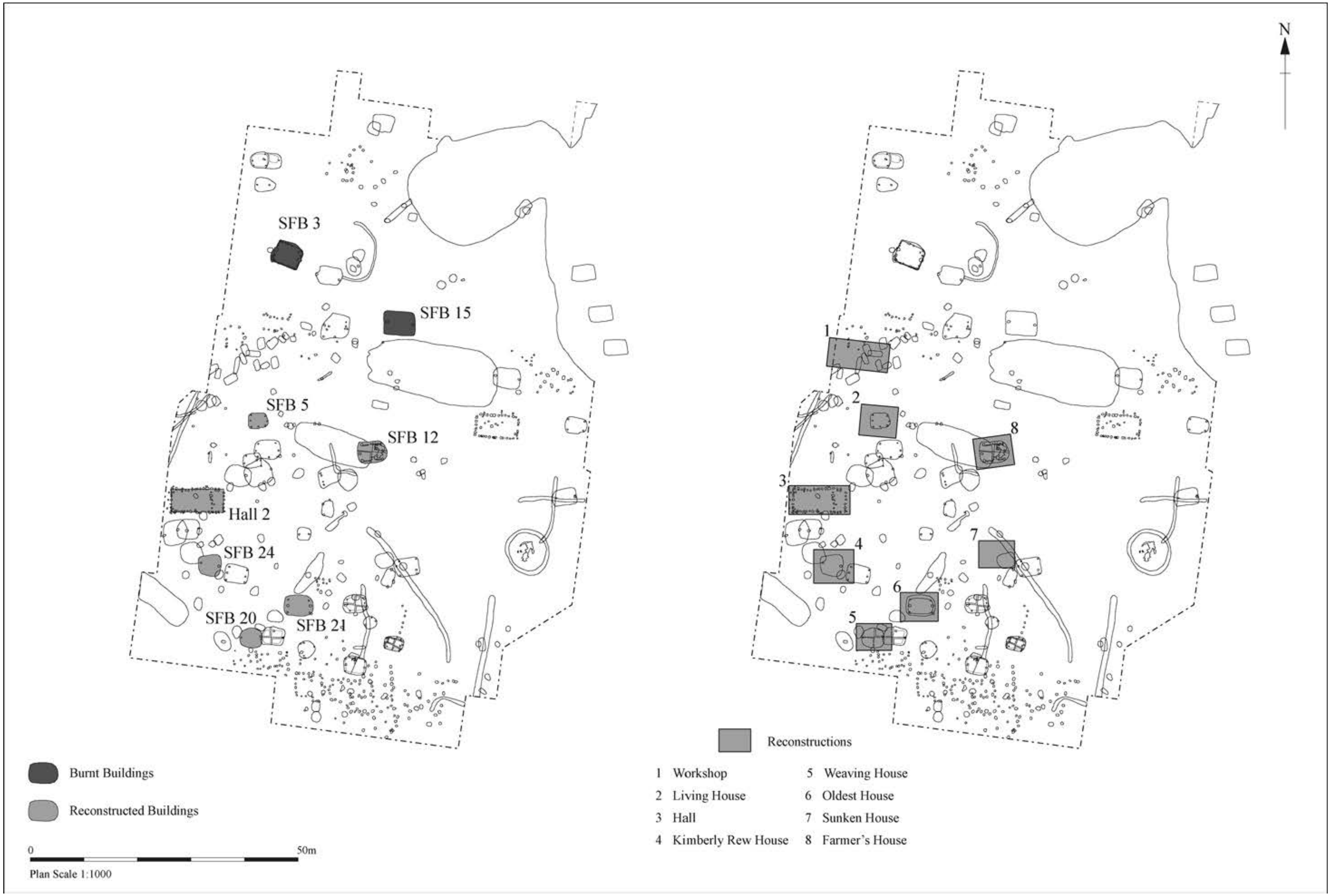


Figure 1.4 Plans of the E half of the Anglo-Saxon settlement showing (left) the buildings that have been reconstructed on their actual footprints, and also the location of the two SFBs that burnt down (SFBs 3 and 15), and (right) all the reconstructed buildings

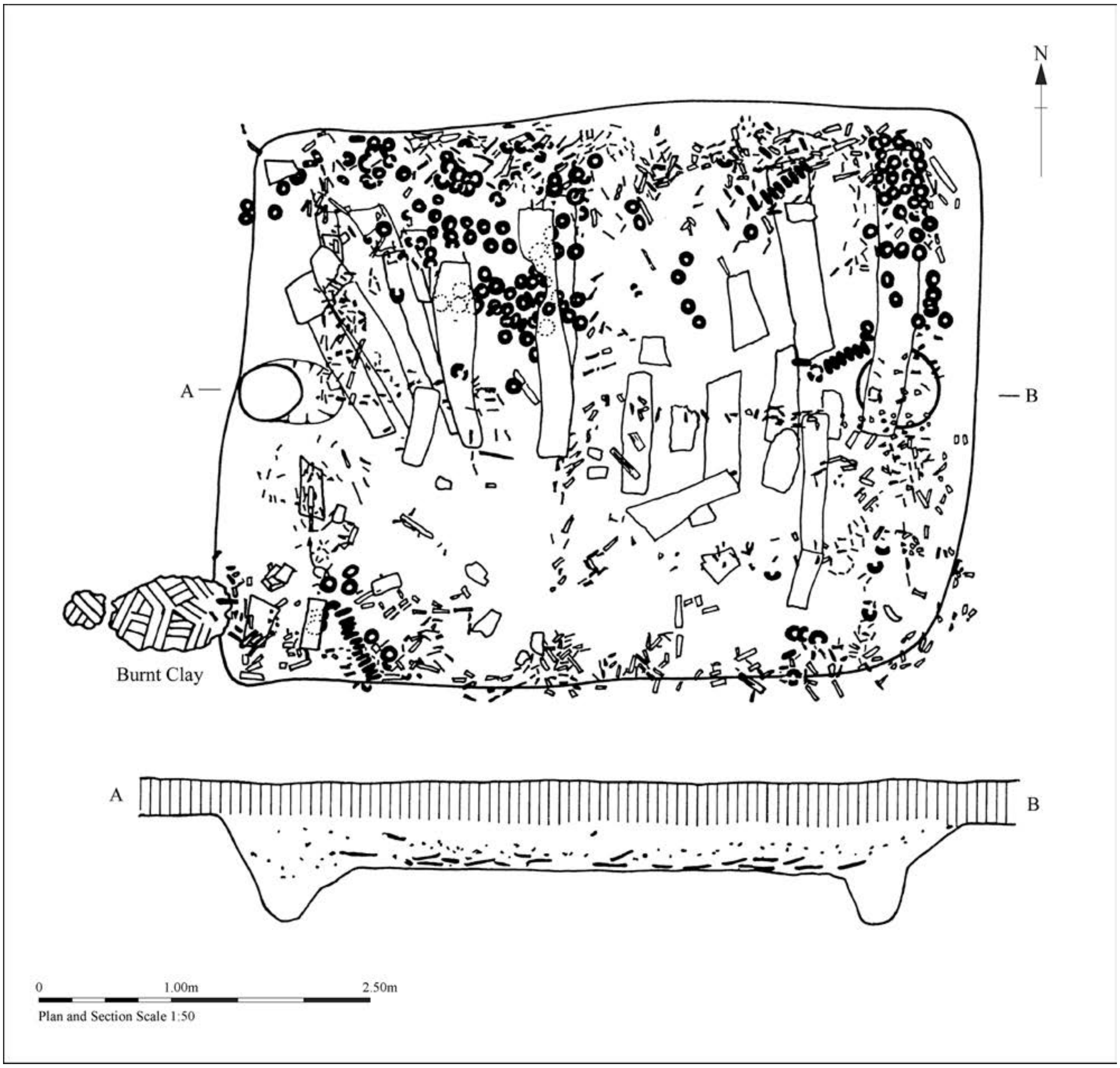


Figure 1.5 Plan and section of SFB 15 that burnt down preserving the evidence of charred planks from the superstructure, interpreted as the remains of floor and wall planks that had collapsed down onto the base of the sunken feature (West 1985, fig. 71)

building which were 'stacked like books on a shelf, presumably as they had dropped from looms' (West 1985, 23). There were also three rows of loomweights on the base of the sunken feature: a row of 13 in the SW corner and rows of eight and six in the NE part of the sunken feature. At least two complete loomweights were located on the upper edge of, and outside, the sunken feature at the NW corner and a row of loomweights in the SW corner appears to be sloping down the side of the sunken feature.

The charred planks on the base were interpreted as the remains of a suspended floor that had collapsed into the sunken feature. The large quantities of loomweights, which sealed the lower charred planks, were interpreted as the remains of several looms that were in the building at the time of the fire, on the suspended floor, which collapsed with the floor into the base of the sunken feature. The three separate groups of loomweights on the base indicated to West there had been three looms in the SFB. The uppermost layer of charred planks, which sealed the loomweights, was interpreted as the remains of vertical wall-boards from the N and S (long walls) which had collapsed inwards and down into the sunken feature. Based on the evidence, West suggested, 'even for the simplest form of *Grubenhaus* (two-post SFB 15) the bivouac type ridge-to-ground roof was questionable' (West 1985, 120).

There were no identifiable remains of the supporting framework in SFB15. There was, however, some evidence of the roofing materials within the base of the sunken feature. There were quantities of fragments of small hazel sticks, up to 0.15m in length, over the loomweights and mainly around the edges of SFB 15. These were interpreted as the remains of the supports for the thatch and they were apparently associated with occasional patches of carbonised thatch.

The fill of SFB 15 contained 18 objects (excluding loomweights), 114 Anglo-Saxon sherds (weighing 761g) and 117 fragments of animal bone. West suggested that

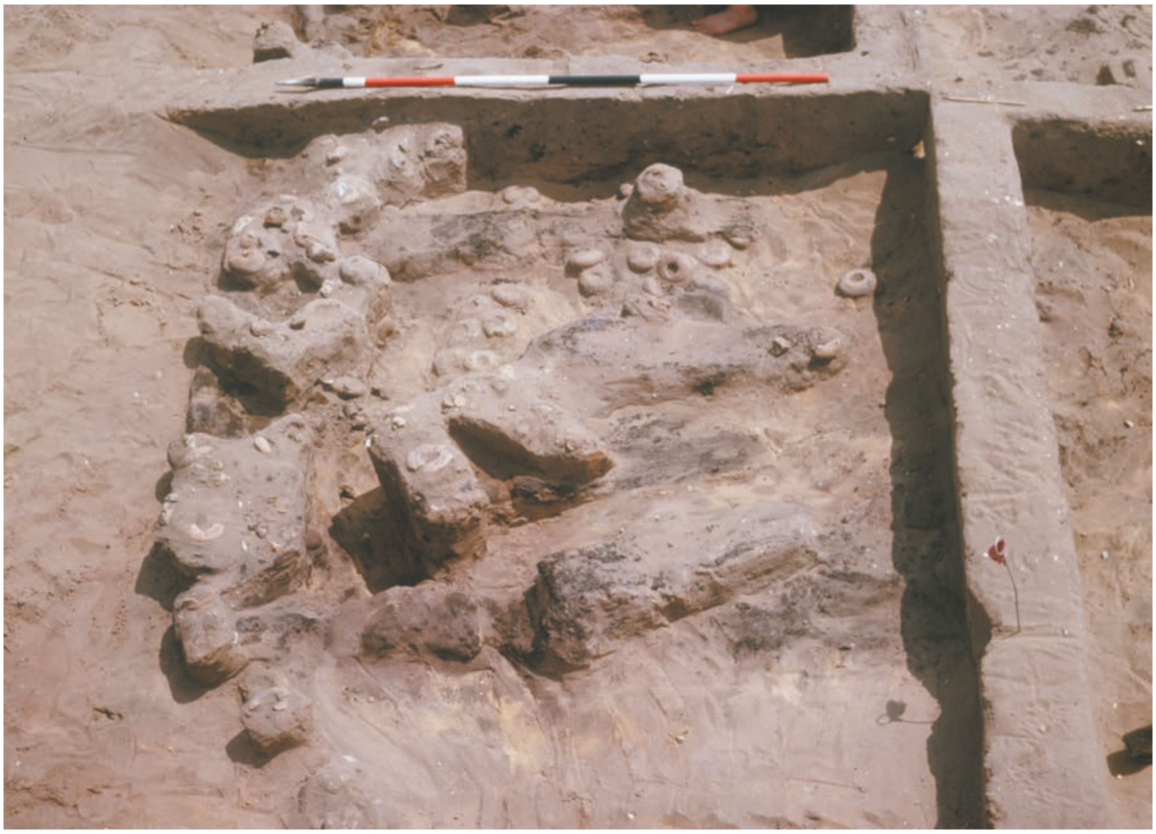


Plate 1.3 SFB 15 during excavation, with the charred planks and loomweights on, and some well above, the base of the sunken feature in the NW quadrant (viewed from NW). Scale at 1ft intervals. *Courtesy of Stanley West*

these could be positively associated with the building. This implies they were in the building at the time of the fire. However, it also seems possible that at least some of these (for example, the sherd fragments) entered the sunken feature as the result of later infilling, because the fill of SFB 15, above the burnt remains of the building, was clearly the result of post-hut infilling. The SFB was phased by West to the late 6th or 7th century. However, the distinctive winged comb from the SFB (West 1985, fig. 73.2) can be now dated to *c*.AD 650–725 (I. Riddler pers. comm.), giving a *terminus post quem* during the second half of the 7th or early 8th century for the destruction of the building[ii].

SFB 3

SFB 3 was also located in the NE part of the site, *c*.18.00m NW of SFB 15 and consisted of an ESE–WNW aligned sub-rectangular sunken feature, measuring 5.20 x 4.10m in area x 0.38m deep (Fig. 1.4). The sunken feature possessed gradually sloping sides down to a level base. Two large post-holes were located centrally along the E and W sides of the pit, *c*.4.90m apart.

Unlike SFB 15, post- or stake-holes were defined in the corners and along all four sides, and straddling the slope, of the sunken feature (West 1985, 16 and fig. 35; Fig. 1.6). The corner post-holes were not, however, substantially larger than the other post-holes around the sides and SFB 3 was classified as a two-post derivative rather than a six-post structure (West 1985, table 46). SFB 3 was the only example of this type at West Stow, with post-holes around the base of the sunken feature, and can be paralleled with a small number of examples across the country with evidence of a similar method of pit lining (Tipper 2004, 74–7 and table 25).

Like the evidence from SFB 15, there was a layer of charred planks lying N–S across the base of the sunken feature, although the individual lengths were shorter and more fragmentary. In the NE part, the charred planks were sealed below a deposit of loomweights, with at least two clear rows of weights; there were 73 loomweights in total from SFB 3 (West 1985, 16 and table 59; Fig. 1.6 and Plate 1.4). According to the report, there were the remains of four planks below the loomweights, two of which were 1.10m long, ranging from 0.20–0.28m wide x 0.04–0.05m thick (West 1985, 16).

Fragments of hazel sticks in the round and up to 0.04m in diameter, 'apparently interlaced, were found all over the SFB, lying on the loomweights and associated with occasional patches of carbonised thatch' (West 1985, 16). West suggested the sticks were 'clearly the supports for the thatch' (West 1985, 16). These and the loomweights were overlaid by the carbonised remains of other planks and timbers. Three of these were identified as small split logs 0.20m across and *c*.0.10m thick and interpreted as the remains of wall planks, while smaller fragments were interpreted as the remains of purlins or rafters.

The fill of SFB 3 contained a small and similar number of finds to SFB 15: 15 objects, 124 sherds (1001g) and 101 animal bone fragments. West also suggested these could be positively associated with the building. The SFB was phased to the late 6th/7th century, on the basis of Ipswich ware pottery from the fill of the sunken feature, above the burnt remains. The fill of this SFB contained three sherds of Ipswich ware pottery, out of only six sherds in total

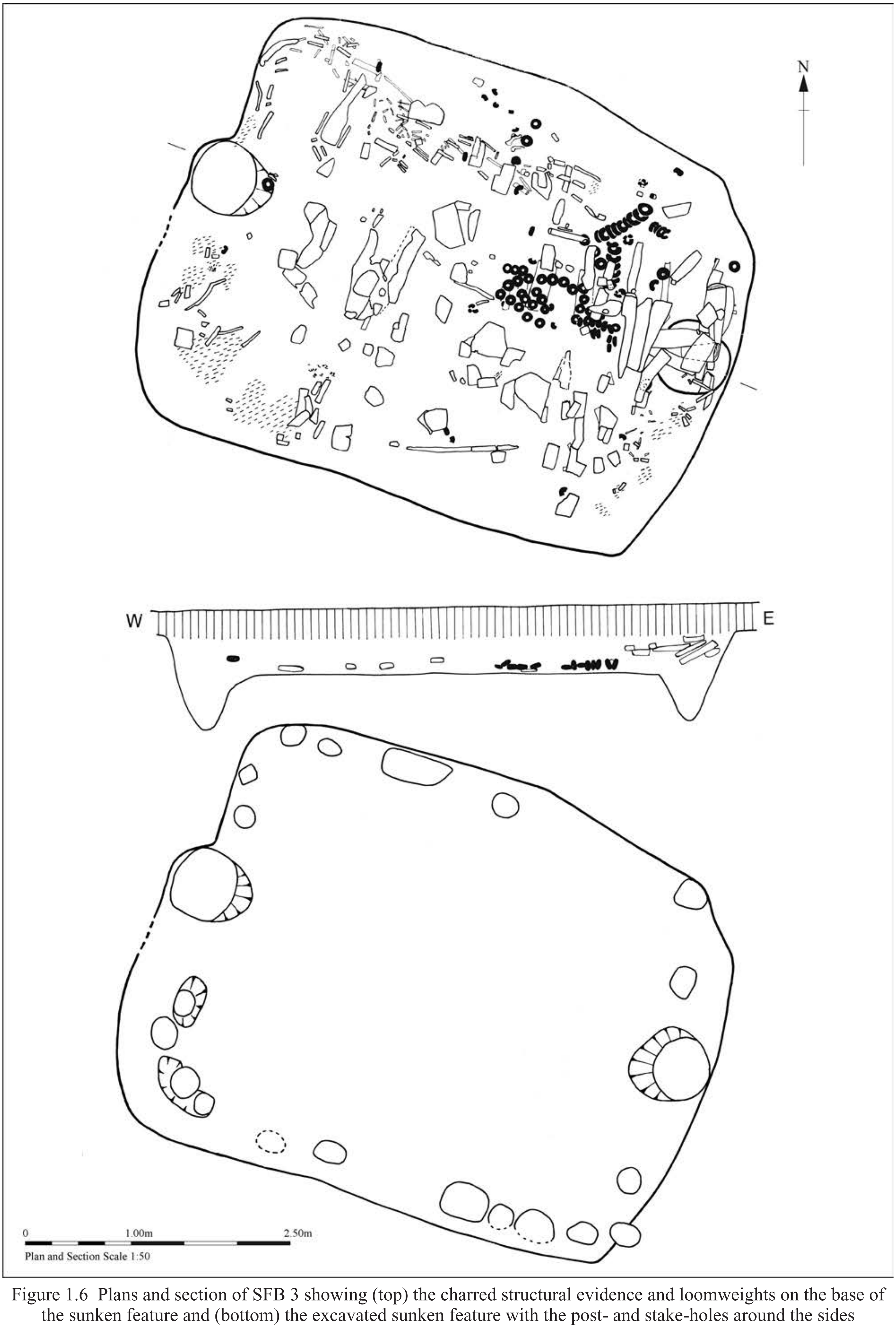


Figure 1.6 Plans and section of SFB 3 showing (top) the charred structural evidence and loomweights on the base of the sunken feature and (bottom) the excavated sunken feature with the post- and stake-holes around the sides (West 1985, fig. 35)

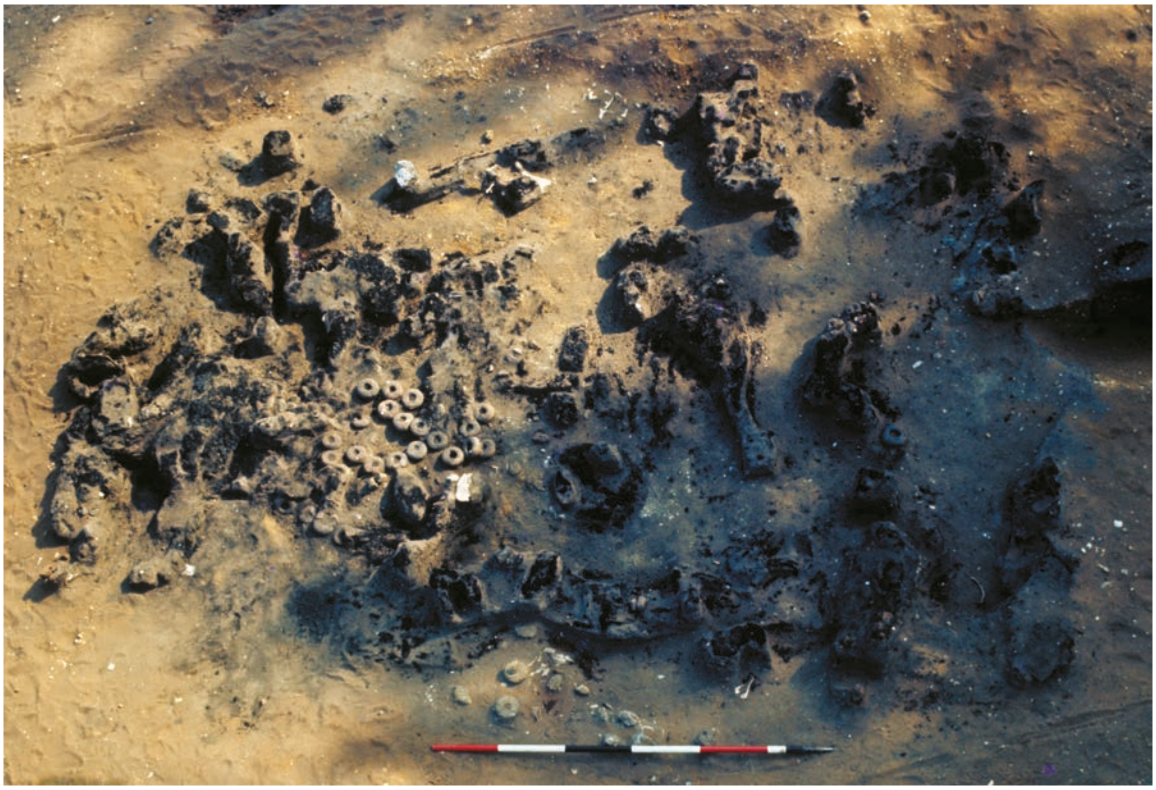


Plate 1.4 SFB 3 during excavation and after the charred remains and the loomweights have been exposed on the base of the sunken feature (viewed from N). Scale at 1ft intervals. *Courtesy of Stanley West*

stratified in or above SFBs (West 1985, 137–8). The chronology for the introduction of Ipswich ware has been revised since the publication of West Stow, and instead of a mid 7th century date, a later date between *c*.AD 715–720 has now been suggested for the introduction of this distinctive pottery in Ipswich (P. Blinkhorn pers. comm.). There were also two datable pins from the fill of SFB 3 (West 1985, fig. 36, 1 and 9). The shaft decoration and head types of both suggest that they are *c*.650 or later in date, up to *c*.750 (I. Riddler pers. comm.). This gives a *terminus post quem* during the early 8th century for the destruction of the building, possibly contemporary with the destruction of SFB 15; perhaps it is no coincidence that both buildings destroyed by fire at West Stow, out of 69 in total from the site, were from the same part of the settlement and have similar, late *terminus post quos* for their destruction (see Chapter 7).

V. The Experimental Village

West Stow remains significant for the programme of reconstructions of Anglo-Saxon buildings on the same site that began in 1973, following the completion of excavations in the previous year and subsequent re-instatement of the topsoil, and it is a unique centre of experimental building reconstruction for this period.

The excavations were undertaken in response to the threat of the encroaching Borough rubbish tip, to the E of the site. In the event, the rubbish tip stopped short of the excavated settlement, and the area was landscaped and re-developed as a country park. In order to preserve the site in some way, St Edmundsbury Borough Council agreed to support the reconstruction project, to test, by practical experiment, the viability of Stanley West's interpretation of early Anglo-Saxon buildings, and in particular his interpretation of SFBs with suspended floors, based on the specific evidence from the excavations (West 2001, 50–1). It is not coincidental that John Coles' *Archaeology by Experiment* was published in the same year as the start of the experimental project (Coles 1973), and the first building was erected by a group of keen students from Cambridge University where Coles was, at that time, Professor of European Archaeology. It also followed the start of Butser Ancient Farm in 1972 that was set up to research, by experiment, the Iron Age and Roman periods (Reynolds 1999, 156).

Six sunken-featured buildings, in total, have been reconstructed at West Stow Anglo-Saxon Village since 1973, five with suspended floors including the Farmer's House (and also one dismantled in 1987) and one with a sunken floor (West 2001; Fig. 1.4 and Table 1.1). There were four earlier reconstructions of SFBs with suspended floors: SFB 21, a six-post SFB completed in 1974 (Oldest House); SFB 24, a two-post SFB completed in 1974 and dismantled in 1987 (Kimberley Rew House); SFB 20, a two-post SFB completed in 1982 (Weaving House; Plate 1.2) and SFB 5, a six-post SFB completed in 1987 (Living House). In addition, and for comparative purpose only, a simple sunken-floored structure has been reconstructed, which was completed in 1976 (Sunken House; Plate 1.1). In this example, the thatched roof slopes down to the ground surface (the classic ridge tent-shaped structure) and the floor is on the base of the pit. There have also been two earth-fast wall-post buildings or halls, including one dismantled in 2000 and subsequently re-built on the same site (The Hall), and one timber-framed building with posts on sill beams (The Workshop). Neither the Sunken House

Excavated Number	Reconstructed Name	Constructed (Dismantled)
SFB 5	Living House	1981–87
SFB 12	Farmer's House	1992–96
SFB 20	Weaving House	1980–82
SFB 21	Oldest House	1973–74
SFB 24	Kimberley Rew House	1974 (1987)
Hall 2	The Old Hall	1975–81 (1999)
Hall 2	The New Hall	2000–2005
	The Workshop	1991
	The Sunken House	1975–76

Table 1.1 Table of concordance for reconstructions and their original, i.e. excavated, names. Neither the Sunken House nor the Workshop reconstructions were based on particular excavated examples and they were not, therefore, erected on the site of original Anglo-Saxon buildings

nor the Workshop were reconstructed on the sites of original Anglo-Saxon buildings.

Each building has been constructed differently to test above-ground structures based on ground-level features from the excavation — to demonstrate how an SFB could be constructed with a suspended floor (taking a two-dimensional design on paper and making it a three-dimensional reality) and thereby seeking a better understanding of how these buildings were made (and used), and also about how (and how quickly) they decayed. Each has been erected on the site of an original sunken feature and constrained by the specific archaeological evidence — re-excavated to the same size and on the same alignment and with the same number and position of posts indicated by their post-holes.

The experimental reconstruction project has been based on West's interpretation of the evidence from West Stow, and all the reconstructions have been built to his design. The project has been a planned progression of development, rather than an immediate and ideal solution, beginning with the simplest technology and progressing to more developed reconstructions, while maintaining the integrity of the evidence. Following the first building, employing the lowest levels of construction, each subsequent building has 'explored and expanded the range of technology and finish', learning from experience (both the successes and failures) of the earlier buildings (West 2001, 71). The overall aim has been to reconstruct a group of buildings representing one family unit, based on West's interpretation of the site — a small settlement comprising two or three family units, each consisting of a central wall-post building or hall surrounded by a group of SFBs (West 1985).

Through a careful balance between archaeology, education and tourism, the aim of the project is to present and interpret the archaeology of the site — one of the first English settlements — through the use of experimental archaeology. Although originally conceived primarily in terms of academic research, to advance knowledge of the period, West Stow is now also a popular 'living history' centre or open air museum although there is occasionally a slight tension, primarily financial, between experiment and entertainment. The West Stow Anglo-Saxon Village Trust is responsible for the authenticity and integrity of the Village, with a strong support group of Friends volunteers, and it is now run in a partnership with St Edmundsbury Borough Council, which is responsible for the day-to-day management and funding of the site.

Experimental reconstructions of early Anglo-Saxon SFBs have also been erected at several other sites across the country. In 1971, a sunken hut was constructed at The Weald and Downland Open Air Museum (Singleton) in Sussex (Webster and Cherry 1972, 163) and in 1999 a *Grubenhaus* with a sunken floor was constructed at Bede's World in Northumberland (Mills 1999, 70–1). In England, these have been based on specific archaeological evidence (the *Grubenhaus* at Bede's World was based on the evidence from New Bewick; Mills 1999, 70–1) but none are on the actual footprint of the original structures. Moreover, without exception, these have been constructed with sunken rather than suspended floors and West Stow is the only site where experimental buildings have been constructed with suspended floors. A number of examples have also been constructed at Living History centres on the continent.

VI. The Farmer's House fire

The Farmer's House was the most recent reconstruction of an SFB at West Stow, built between 1992 and 98 (Plate 1.5). It was also the most sophisticated reconstruction of an SFB at West Stow, with a suspended floor above a lined cellar. Although not necessarily any more correct than the simplest reconstruction, the design also benefited from the considerable experience and practical knowledge accumulated from 20 years of experimentation at West Stow. The walls consisted of split oak timbers, pegged into place onto the oak frame and the roof was thatched with modern wheat straw on ash and split ash rafters. The form of this reconstruction is discussed in detail in the next chapter.

During the early hours of 19 February 2005 the Farmer's House was destroyed by fire. As previously stated, it was not intentionally set alight as part of a planned archaeological experiment, although in the past it has been suggested by some that it would be instructive to set light to a reconstruction of an SFB to record how they would burn and what the evidence might look like. Instead, the fire appears to have been the result of arson and caused by intruders during the night, accidental or not. There was no fire in the Farmer's House on the day immediately before the fire, so it does not appear to be the result of negligence by staff who would normally ensure all fires are extinguished when the Village is closed up each night. This is supported by the detailed investigation of the remains in Chapter 3 but, at the time of the fire, this was an assumption; both the origin and cause of the fire were important research questions (see below). Whoever started the fire presumably escaped unharmed and the intruders have not been caught.

Security has been an issue within the Village at night and on several occasions the buildings have been entered and fires lit (beer cans recovered one morning pointed to an unauthorised break-in) and, therefore, the fire that caused the destruction of the Farmer's House might have been started without intent. As a result of the fire, a perimeter fence was erected around the Village to deter intruders. Despite this, the Village has been broken into; on 2 June 2008, during the night, a fire was lit in the Hall by intruders, and put out (by them) with a fire extinguisher.

Plate 1.5 The Farmer's House reconstruction at West Stow; the most sophisticated reconstruction of an SFB with a suspended floor over the sunken feature, lined with substantial timber planks, which acted as a cellar (viewed from SE). Notice the log piles stored along the S wall of the building below the eaves and the hollow that has formed in front of the entrance and window

Assuming it was not started deliberately with the intent to destroy the building, no attempt appears to have been made by the intruders to put out the fire in the Farmer's House using the fire extinguisher, because the remains of the extinguisher were found close to its original position in the SW corner of the building. However, it took three extinguishers to put out a small accidental fire below the fire-box in the same building five months earlier, and it is therefore unlikely that the extinguisher would have had any effect given the speed at which fire can take hold, and spread, in this type of structure (Chapter 6).

Fortunately, for the purposes of understanding the process of destruction, the building was allowed to collapse without any interference, although it was monitored by the Suffolk Fire Service, and no attempt was made either to contain or put the fire out[iii]. Therefore, the process of destruction and collapse was allowed to run its natural course. Any attempt to put the fire out or, subsequently, to disturb the remains in order to ascertain the cause, would have made this investigation pointless or, at least, would have severely limited the potential research objectives of the project.

VII. Research objectives

The destruction of the Farmer's House was a set-back to the Anglo-Saxon Village, and particularly disheartening to those who helped erect it. However, it did represent a unique opportunity for experimental archaeology and a project was instigated to maximise the research potential of the fire. As Coles stated in 1973, 'a sequence of excavation plan→ reconstruction→ destruction→ excavation plan provides a model which can be tested for fit' (Coles 1973, 63).

The following research aims were put forward at West Stow:

i. to use the evidence from these remains to inform the debate about the nature of fires relating to buildings in the archaeological record, and also as a resource for future discoveries, specifically relating to the (re-) construction of SFBs

ii. to use the evidence from these remains to inform on issues of site formation processes given the detailed knowledge of the original reconstruction and the location of furniture and fittings within the building

iii. to understand the nature and dynamics of the fire through a detailed examination of the evidence — to identify the seat of the fire and possibly the cause of the fire, and also the development of the fire because different models should potentially result in radically different patterns of burning.

In addition, a number of secondary objectives were addressed, using the evidence as an opportunity to inform , and test, a suite of scientific techniques and methods currently used to analyse archaeological remains:

iv. to use thin-section micromorphological analysis to compare the fills of the pit with the archaeological deposits within sunken features, in order to assess the previous interpretations of how these buildings had been constructed and their pits infilled, and to evaluate the potential of a wide suite of faster and cheaper bulk analytical techniques, which have so far been rarely used in the analysis of SFB fills

v. to understand the effect of high temperature oxidation on metals

vi. to investigate more closely the survival and taphonomy of known plant and insect remains contained in, and forming the fabric of, the building as well as the environment in which it stood, which will help to establish how easy it is to identify the presence of roofing in particular archaeological deposits and how large burnt timbers survive over long periods. A selection of partially charred timbers from the fire was collected and buried within four separate pits, away from the site of the burnt building but within the Village, with a view to re-examining them at five-year intervals to assess the progressive rate of decay

vii. to suggest an appropriate recording and sampling strategy for such burnt remains in the archaeological record.

Another important aim was to enhance public engagement with, and understanding of, this project and also experimental archaeology.

The reconstruction and this fire were unique and, therefore, the results are limited in so far as they are applicable to informing the debate about the construction of SFBs in general because of the number of variables involved in the project. The Farmer's House was simply one possible interpretation of the form of this building-type, i.e. with a suspended floor and with a deep and also lined pit or cellar, that was different from the other three reconstructions of this type at West Stow, which had shallower, unlined pits. Similarly, had the cause of the fire been different, the remains could have looked very different. Nevertheless, the evidence from this building raises possibilities, and further questions, and it does help considerably in our understanding of the evidence of this building-type, as well as issues of formation processes and it also helps our understanding of fires more generally in the archaeological record.

It is hoped that the detailed record generated here will be used for comparison with future discoveries of burnt buildings in the archaeological record, and also any future experimental explorations that will hopefully receive equally detailed recording. Several experimental reconstructions have been destroyed by fire, as part of planned projects or not, although by far the best known, and also most comprehensively investigated, is the house-burning event at Lejre in 1967 (Rasmussen 2007). Most of these have been reconstructions of prehistoric long- or round-houses, with the floor level at ground surface — quite different in structural form to the Farmer's House. There is now at least one example of an Iron Age sunken house reconstruction, with the floor level on the base of the pit, that was destroyed by fire (again, by an unauthorised person and not as part of a planned experiment), at an archaeological open air museum in the Czech Republic in 2006 (Waldhauser 2008). However, discussion of fire in the archaeological record has been, until recently, limited and interpretations have been based on assumption and surmise (Harrison 2008).

VIII. Excavation methodology

During July and August 2005 the burnt remains were recorded, excavated and sampled in detail by a small team from Suffolk County Council Archaeological Service under the direction of the principal author, assisted by a small team of specialists and expert advice. The complete archive was recorded under the Suffolk HER site code WSW 060 and is lodged with Suffolk County Council Archaeological Service.

The main aim of the fieldwork was to make a detailed record of the remains of the building comparable to a conventional archaeological excavation, so that the results could easily be compared to excavated SFBs. A comprehensive photographic record was made of the remains. All the remains were planned at a scale of 1:10, and subsequently digitised.

All remains on the surface around the pit were first recorded and cleared to allow access to the pit itself. The pit was excavated in opposing quadrants (NE and SW followed subsequently by NW and SE) (Fig. 1.7). All the material within the pit was coarse sieved (5mm mesh) and all fills were extensively bulk-sampled for environmental remains. The remains of the thatch ash on the ground surface was also extensively sampled. Micromorphological samples were taken from the sections within the pit and from the pit side, and also outside the pit below the line of the outer floor joist.

The excavations proved to be technically challenging and time-consuming, especially within the pit, where space was limited and where every footstep could (potentially) damage the fragile remains of charred timbers. Moreover, the sand infilling the pit was unconsolidated (unlike most conventional archaeological excavations where compression and consolidation of deposits infilling subsurface features is the norm) and, therefore, sections proved extremely difficult to maintain. On several occasions large blocks of sand broke away from the pit sides and collapsed onto the remains in the base of the pit during excavation.

All substantial and recognisable charred timbers were planned and given individual context numbers, recorded on conventional context sheets (the context numbers are used in the archive report but not in this publication). All the artefacts both within and around the area of the pit, including each individual pot-sherd from the broken vessels, were carefully excavated and drawn, and given individual numbers. These, and also the charred timber remains, were three-dimensionally recorded using a total station (over 3,200 readings in total with over 400 metal items and nearly 400 pot-sherds, including many pencil leads that are the remains of pencils that were lost below the floor boards).

IX. Layout of the volume

In Chapter 2, the archaeological evidence for SFB 12, the remains of an early Anglo-Saxon building excavated at West Stow, is examined (West 1985). The physical evidence from SFB 12, principally a lined sunken feature or pit with six associated post-holes, formed the basis for the reconstruction that was destroyed by fire; the Farmer's House was also located on the same footprint, and utilised the same pit and post-holes as SFB 12. This leads to a more general discussion about the reconstructions, followed by a detailed description of the Farmer's House.

In Chapter 3, a detailed examination, both descriptive and interpretative, of the burnt remains — both the structure and its contents — is undertaken, based on the surviving physical evidence and supplemented with the evidence provided by the images taken both during and

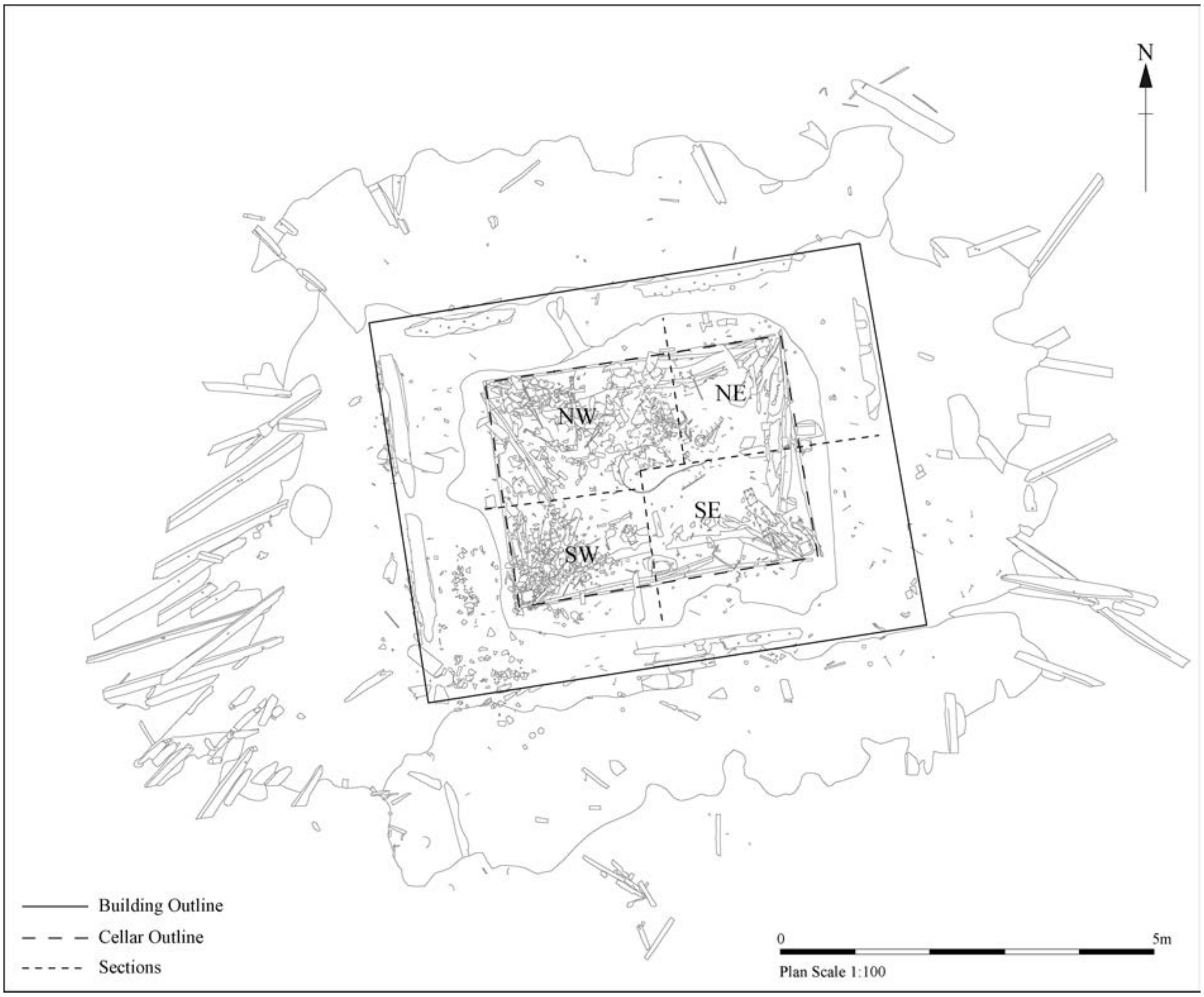


Figure 1.7 Plan of the Farmer's House remains showing the four quadrants of the cellar pit

after the fire, during the period between the fire and the excavation. In addition, ten replica metalwork objects from the remains were analysed by Vanessa Fell, to investigate the effects of burning on metal objects and to characterise the metal oxidation products from the fire and these are also discussed in this chapter (Fell 2007).

In Chapter 4, the detailed evidence from a range of scientific techniques is examined and, in each section, the implications of this experimental work for the study of conventional archaeological remains is discussed. The evidence from the study of soil geochemistry and soil micromorphology is presented by Karen Milek and Charly French. The study of plant and insect remains, from intensive bulk sampling of deposits, much like the strategy that would currently be used to sample a conventional archaeological feature, is discussed by Gill Campbell and Harry Kenward in Chapter 5. In the same chapter, plant recolonisation is discussed by Rachel Ballantyne.

An analysis of the burnt remains is undertaken by Karl Harrison in Chapter 6, using a range of techniques developed in forensic fire investigation to develop both an understanding of the origin and processes of combustion in the Farmer's House and to develop a better understanding of the complexities of structural fire, more generally, within the archaeological record.

The often painstaking and detailed level of recording, together with the images taken during the final stages of the fire, has enabled us to understand how the building collapsed and how the contents were broken and dispersed across the remains, which would not otherwise have been possible. The results are discussed more generally in Chapter 7 along with some of the implications for understanding and interpreting the archaeological record. This allows comparisons to be made with the few previous investigations of burnt Anglo-Saxon SFBs, and the archaeological evidence of SFBs 3 and 15 at West Stow is re-interpreted in the light of the information gained from this experimental project.

Endnotes

i The term reconstruction is used here although Reynolds (1999, 159) preferred the term 'constructs' for structures such as these that are based largely on the ground plans.

ii It is unclear from the report whether the comb came from the burnt layer, which would demonstrate it was inside the building, or from the material infilling the sunken feature which would demonstrate that it was deposited at some point after the building's destruction.

iii However, the Fire Service did spray adjacent buildings with water to prevent the spread of the fire to other buildings that were only several metres from the Farmer's House. Fortunately, for the rest of the Village, the prevailing wind carried the sparks away from the other buildings.

2. Construction

I. Introduction

The Farmer's House reconstruction was based on the specific but limited archaeological evidence from SFB 12, combined with the other strands of evidence from the excavations at West Stow that led to Stanley West to reconstruct SFBs as sophisticated ground-level buildings rather than as more rudimentary sunken-floored buildings. In the first part of this chapter, a review of the archaeological evidence for SFB 12 is undertaken. This is followed by a detailed discussion of the design of the reconstruction. The chapter finishes with an inventory of the fittings and furniture in the building prior to the fire.

II. Archaeological evidence for SFB 12

The Farmer's House was constructed on the site of SFB 12, the remains of an Anglo-Saxon SFB located on the E half of the knoll. SFB 12 was excavated in 1966, back-filled after the excavation and subsequently re-excavated in 1990 for the reconstruction (West 1985, fig. 300; Figs 1.3 and 2.1, Plates 2.1 and 2.2).

West dated the SFB to the 6th century AD based on the presence of a distinctive antler pottery stamp within the fill of the sunken feature (one of two within the fill of this sunken feature), which was apparently very similar to a stamp impression on a decorated cremation urn from the Anglo-Saxon cremation cemetery at Illington, in Norfolk (West 1985, 148–9 and fig. 61.14). There is no reference to this possible stamp-link in the report on the Illington cemetery; it is possibly the same as that used on Vessel 151 SG 25 (Briscoe stamp H4aii) but no detailed analysis has been undertaken between the two assemblages (Davison *et al.* 1993, 17, 33, fig. 37 and table 3). The cemetery at Illington is dated generally to the 6th century (Davison *et al.* 1993, 17).

SFB 12 consisted of a sub-rectangular sunken feature or pit aligned ENE to WSW, measuring 5.50m x 4.30m in surface area (West 1985, 20 and fig. 59 and 59A). The sunken feature possessed sides sloping down to an irregular and concave base, *c*.4.00m x 3.30m in area. It measured *c*.0.75m in depth from the stripped surface, although it was estimated to be just over a metre deep from the Anglo-Saxon ground surface. It was one of the largest SFBs excavated at West Stow, second only to SFB 15 (5.80m) in length. It was also one of the deepest; only six SFBs were deeper than SFB 12, with the deepest (SFB 17) at 1.00m (West 1985).

Nine post-holes were defined in association with the sunken feature, which was interpreted as the remains of a six-post derivative structure. However, there was variation in both the size and depth of the post-holes. There were two large ridge post-holes, located centrally along the short E and W sides, and on the central axis, of the sunken feature, *c*.4.20m apart. These measured 0.57m (E) and 0.30m (W) in depth. Post-holes were defined in all four corners, set in the angle of the slope at the base of the

Plate 2.1 SFB 12 at an early stage of excavation. The deposit of clay, tipping down into the sunken feature from the E and sealing the lower fill, has been exposed in the two E quadrants (viewed from N). *Courtesy of Stanley West*

sunken feature. These lay in a staggered arrangement with the ridge post-holes; the ridge post-holes lay outside the line of the corner post-holes. The corner post-holes were *c*.3.75m apart E–W and *c*.3.00m apart N–S. Single large post-holes were defined in the NW, SW and SE corners with two smaller post-holes in the NE corner. The corner post-holes ranged from 0.23m (outer post-hole in the NE corner) to 0.61m (SW corner) wide and from 0.15m (outer post-hole in the NE corner) to 0.61m (SW) deep.

A further two small and very shallow post-holes lay on the N and S sides, diagonally opposed across the sunken feature. The N post-hole was located roughly centrally along the side while the S post-hole was off-set to the W by *c*.0.30m. These post-holes were altogether much smaller than the other post-holes, measuring 0.08m (N) and 0.11m deep (S) and both *c*.0.20m wide.

SFB 12 was unique at West Stow in possessing narrow slots at the base of the sides indicative of plank lining, and it was one of only a few that had any evidence of lining (West 1985, fig. 59). Two SFBs (8 and 26) had a wide shallow trench around the base of the sunken feature that might have contained a turf wall, although the fill of each trench was indistinguishable from the uniform fill of the SFBs (West 1985, 18, 29, figs 47 and 104). SFB 3 showed signs of lining that consisted of individual post- and stake-holes around the base of the sunken feature (West 1985, 20 and fig. 35; Fig. 1.6).

In SFB 12, four narrow slots were defined at the base of the N and S (long) sides of the sunken feature, ranging between *c*.0.10–0.15m wide and 0.08–0.15m deep. Two slots along the N side measured *c*.1.15m (W) and *c*.1.35m long (E), between the corner post-holes and the central post-hole, although slightly off-set to the S of the latter. Two slots on the S side were 0.95m and 1.05m long respectively; there was a gap of *c*.0.90m between the E slot and the (off-set) central post-hole. However, unlike the opposite side, the two slots were in direct alignment with the corner and central post-holes. The slots indicate that the N and S sides of the pit had been lined. There was no evidence of slots along the shorter E and W sides of the sunken feature.

It is unclear how the slots would have functioned. There was no evidence of plank remains (such as sand staining) within any of the slots, to indicate the form of the lining, whether horizontal or vertical planks. The slots along the N side of the sunken feature were situated to the S of the central post-hole and based on this arrangement the lining would have been in front of the posts and not wedged behind them. The slots on the S side were in line with the central post-hole and also with the corner-posts, which also indicates that the planks were not slotted behind the posts. Furthermore, the central post-holes were very shallow (0.10m deep max.) and, by themselves, it is doubtful they would have supported the planks against the inward pressure of the sides.

There was no evidence to show that the base of the sunken feature had formed an occupation surface. The interface between the cut and the lowest fill was sharp and well-defined and there was neither a prepared, trampled nor eroded floor surface. The base of the pit was uneven and sloped down towards the W, forming a hollow in front of the W ridge post-hole (West 1985, fig. 59a). It seems clear from this evidence that the SFB did not possess a planked floor on the base of the pit, as it was too irregular to accommodate any form of planking. Nevertheless, the evidence of lining combined with the depth might suggest that the sunken feature was intended for access and use.

The N and S sides of the sunken feature sloped down quite gradually at an angle of *c*.40–50 degrees, even though there was evidence to indicate these sides were lined. If the slots along the base of the sunken feature are projected upwards, assuming plank lining within the slots,

Plate 2.2 SFB 12 towards completion of the excavation, although the post-holes and slots along the base of the sides have not yet been investigated (viewed from S). *Courtesy of Stanley West*

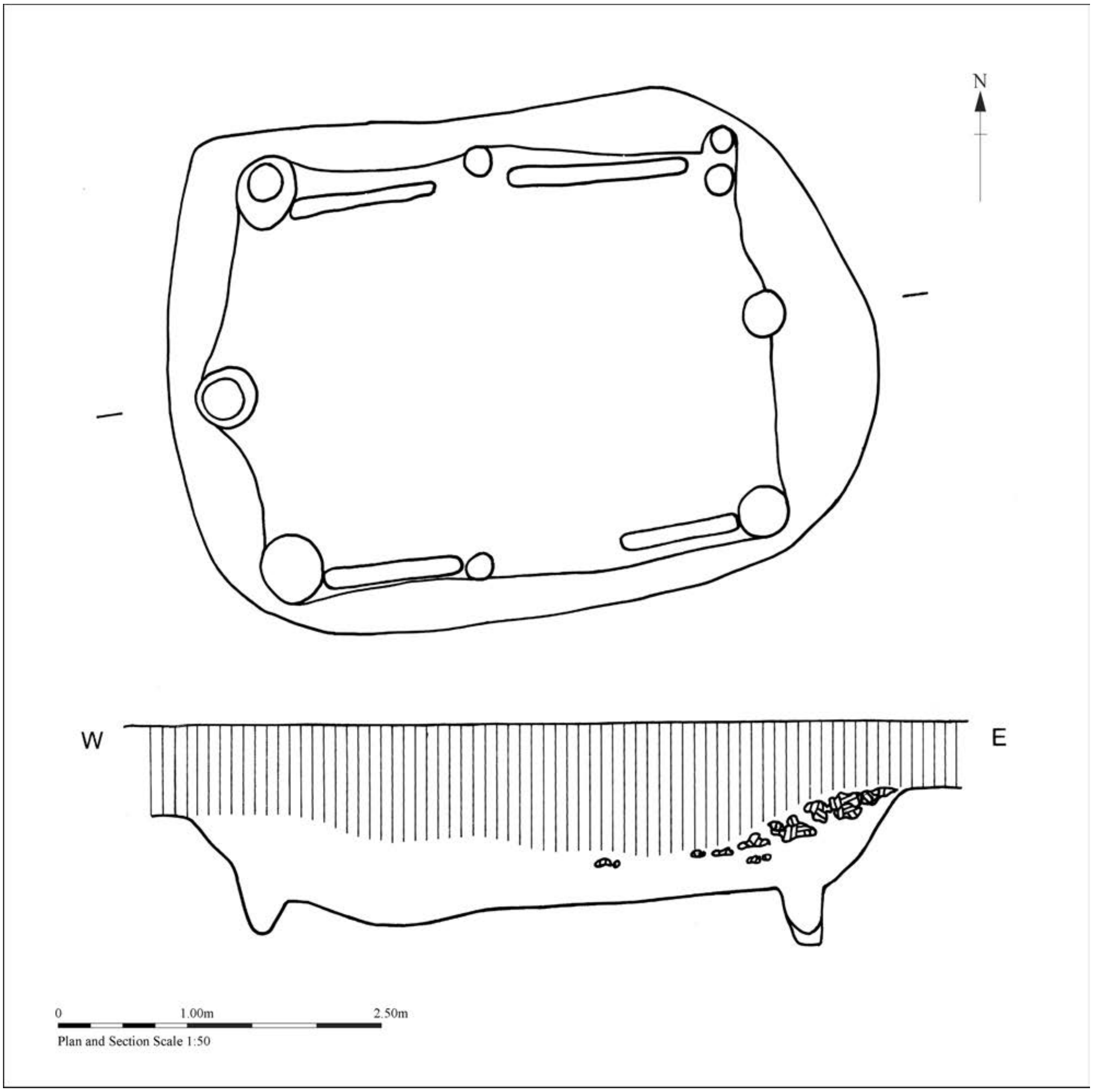


Figure 2.1 Plan and section of SFB 12, which formed the basis of the Farmer's House reconstruction (West 1985, fig. 59). A deposit of clay, tipping down into the sunken feature from the E side, sealed the lower fill that Stanley West suggested had accumulated below the suspended floor during the use of the building

there would have been a gap of between *c*.0.40–0.60m between the lining and the top edge of the sunken feature (even more if the ground surface was another *c*.0.30m higher than the stripped surface and the slope continued at the same angle). This might suggest either that the sides were originally cut on a slope and battered, in which case the area between the planking and cut of the sunken feature must have been backfilled after the lining had been erected, or that the sides, presumably along with the lining, had at some point collapsed into the pit.

There was, however, no evidence for side collapse in the base of the sunken feature. There was also no evidence to show that material had accumulated against lining that had simply decayed *in situ*. The lack of evidence for either might suggest that any side collapse was simply indistinguishable within the lower fill, which has implications for the nature of SFB fills and post-depositional re-working. There was little difference between N–S and E–W sections, although only the N and S sides of the sunken feature showed evidence of lining.

The fill of the sunken feature was characterised by two main and distinct fills. Based on the original field-drawings, the lower fill consisted of a yellow-brown (grey-brown in the publication) silty fill, *c*.0.45m deep (max.), which sloped down into the centre of the sunken feature. The field notes record a considerable quantity of bones in the top of this layer, towards the centre of the sunken feature. Like other lower SFB fills at West Stow, this fill was interpreted by West as a primary occupation deposit that accumulated below a suspended floor during the use of the building; however, this has subsequently been re-interpreted as post-use infill, deposited after the building had been dismantled (Tipper 2004).

This lower fill was sealed by a substantial deposit of clay, complete with many wattle impressions and partially reddened with burning, and charcoal, concentrated in the E part and sloping down into the hollow, *c*.0.23m thick (max.). This deposit was interpreted as the remains of a fire-backing which lined the E wall of the building, although no evidence for an actual hearth base was recovered (West 1985, 41, 120, figs 149 and 166). The material was not retained in the archive and is not, therefore, available for further analysis.

The burnt clay was sealed by the upper fill, described as a grey ash-rich fill in the archive (dark brown-black in the publication), *c*.0.45m deep (max.), containing much charcoal and above a thicker band of charcoal towards the centre of the hollow. This was interpreted as a post-abandonment deposit, which formed within the hollow after the building had been dismantled.

The fill of SFB 12 produced a substantial finds assemblage. However, it would appear that finds were recorded collectively, using a single context number 135 and no distinction appears to have been made between the upper and lower fills in terms of the finds[i]. It is, therefore, problematical to make direct comparison with the material from other SFBs, where the distinction between upper and lower fill was made.

The finds included a fragment of silver with gilded and chip-carved surface, a girdle hanger, fragments of six bone combs and two pottery stamps. The fills also produced loomweight fragments, four spindle whorls, four bone pins or needles and two possible bone awls. The fill contained over 700 sherds of Anglo-Saxon pottery (West 1985, table 60).

The fill of the sunken feature also contained a very large assemblage of animal bone, with over 12,500 fragments from context [135] (again, this includes both upper and lower fills). The species ratios based on NISP for the main domestic species from SFB 12 show a predominance of sheep/goat (44.1% or 1518 fragments), followed by cattle (39.9% or 1374 fragments), pig (15.1% or 521 fragments) and horse (0.9% or 32 fragments) (P. Crabtree pers. comm.).

III. Archaeological evidence to experimental reconstruction

The Farmer's House was based on the evidence from SFB 12 and constructed with six structural posts, indicated by the six post-holes. The sunken feature was plank-lined, indicated by the slots around the base. Combined with the considerable depth of this sunken feature, lack of an apparent entrance, and lack of evidence for a floor surface on the base, West suggested this space was possibly utilised as some sort of cellar. The building was constructed with a suspended planked floor above the sunken feature, with vertical planked walls and a thatched roof based on West's interpretation of the evidence, i.e. that SFBs were sophisticated buildings with suspended floors.

The experimental reconstructions at West Stow are based on limited archaeological evidence. There was no evidence to indicate the form of the superstructure outside the sunken feature (of this or any other SFB at West Stow), despite the preservation of a substantial surface deposit (Layer 2) that was carefully cleaned. The lack of post-holes around the surface of sunken features limits the interpretation of how they might have been constructed. This led West to reconstruct this and other SFBs with an interlocking frame resting directly on the ground surface, onto which both the floor planks and wall boards were pegged. Above ground, however, the constructs are largely conjectural.

There is an assumption in these, and other, experimental reconstructions about 'the logic of construction' which implies that the original builder used each timber in a rational way (Dixon 2002, 90). In the Farmer's House, West showed how an SFB with a suspended floor might have been constructed. It is a viable interpretation of the very limited archaeological evidence which, by practical experiment, has been shown to work. However, there are other, equally valid, possibilities; for example, accepting their construction with suspended floors (which is itself open to debate, see above), the position of the walls in relation to the sunken feature (and therefore the size of the actual building) is also open to debate. West suggested the walls were set well back from the upper edge of the sunken feature, resulting in a building considerably larger than the sunken area (West 1985, 115). However, it is also possible that the walls were set much closer to the edge of the sunken feature; there is little archaeological evidence to support either assertion.

Moreover, the relatively large and deep central ridge post-holes have frequently been taken to indicate the use of substantial axial or ridge-posts that extended to the apex of the roof, to carry a ridge beam[ii]. Even this assumption is open to debate. It is possible the posts only extended to the height of the wallhead, with a simple A-frame roof and without a substantial ridge beam. It is possible that roofs of SFBs were hipped rather than gabled (whether or not they had a ridge beam); the evidence of weak or rounded corners in contemporary ground level wall-post buildings or halls, which is repeated across the country, suggests that the roofs of these might have possessed hipped ends (Dixon 2002, 99). SFBs could have been, and probably were, constructed in a variety of ways; their pits vary considerably in area and depth, even allowing for variable preservation, and the post-holes vary in number, from none to six, in some cases more. The reconstructions at West Stow do not prove these buildings had a suspended rather than a sunken floor, they merely show what might have been possible.

An attempt has been made to employ the woodworking tools and techniques consistent with the evidence of the period although the actual archaeological evidence at West Stow, and elsewhere during the early Anglo-Saxon period, is very limited; many of these discoveries have been made, and published, subsequent to the erection of the earlier experimental reconstructions.

There are woodworking tools of this period, such as axes, adzes, chisels, spoon augers and draw knives, and several hoards of woodworking tools, found elsewhere in the country, although many date to the mid to late Saxon or Anglo-Scandinavian period and individual items are often difficult to date accurately (Wilson 1976, 253–8; Darrah 2007, 60–1; Lucy *et al*. 2009, 265–7 and fig. 4.49). These can be compared with the evidence of tool marks on surviving timbers. There is no evidence for the use of any type of saw during the Anglo-Saxon period in the production of structural timbers, based on the timbers that have been preserved through waterlogging (Wilson 1976, 257). In London, there is no evidence for the use of a saw until the 13th century. Therefore, the trees would have been felled, lopped and cut into required lengths (bucking) with an axe, before conversion by axe, and possibly adze, into finished timbers (Goodburn 1992, 108 and 113). At Staunch Meadow, Brandon and at Flixborough a narrow bladed axe would have been used for felling and hewing with a broad bladed axe for finishing (Darrah 2007, 60; Darrah forthcoming). Similarly, at Coppergate, York, felling and trimming axes were used to cut timbers to the required length, to prepare and trim posts and planks, and cut joints (Allen and Spriggs 2002).

The surviving evidence, such as it is, indicates that woodworking techniques were relatively simple during the Anglo-Saxon period compared to the later medieval period. There is, however, more substantive archaeological evidence for timber building techniques from the late Saxon and Anglo-Scandinavian periods onwards, particularly from urban contexts.

The timbers for the Farmer's House reconstruction have been produced using a combination of timber conversion methods. The posts, beams and plates were of boxed heart, with logs simply squared-off by axe and with both bark and sapwood removed. The floor planks were box-halved, with logs simply split down the middle to form two planks. The underside of each plank was left in the round after the bark had been removed, trimmed and smoothed off. The cellar lining consisted of tangentially cleft planks, whereby logs are box-halved, hewn and finished by axe to produce two planks. The wall boards were radially cleft, with logs split using wedges, in half and half again and with bark and sapwood trimmed off, to create boards of the required thickness and with a distinctive triangular-shaped profile. The cladding timbers were face-pegged to each other and to the wall- and base-plates; a simple rebate was cut along the inner and widest edge of each plank to receive the thin edge or tongue of the adjacent plank to give a snug fit, which is a variant on the timber-built wall types A and B listed by Darrah 2007 (fig. 3.21; after Goodburn 1994, fig. 5).

The carbonised remains from SFBs 3 and 15 demonstrated the use of substantial dressed planks in their construction and suggest that both buildings destroyed by fire were timber-heavy. The surviving charred planks had an original plank thickness of *c*.0.06m (max.) and width of *c*.0.25m (max.) (West 1985, 20). However, there was no detailed analysis of the carbonised timbers and it is not known whether the planks had been tangentially or radially split. The absence of burnt clay suggests that daub was not used in either of these buildings although, rather surprisingly, the remains of an experimental reconstruction of an Iron Age roundhouse, originally with daub walls, destroyed by fire at Butser Ancient Farm apparently produced only a single fragment of burnt daub (Reynolds 2000, 97). That said, the sunken feature of a large Anglo-Saxon SFB, interpreted as a sunken-floored building, that had been destroyed by fire in Old Swindon was filled with burnt clay from the superstructure of the building (Canham and Phillips 1976; B. Phillips pers. comm.) while the Anglo-Saxon building at Upton, also destroyed by fire, produced a substantial deposit of burnt daub, probably from a side wall that collapsed inwards and downwards into the base of the sunken feature (Jackson *et al*. 1969, 208 and fig. 5). Several late Saxon cellared buildings in Ipswich, also destroyed by fire, each produced over 200kg of burnt clay (Wade 1994; T. Loader pers. comm.). This evidence suggests, *contra* the evidence from Butser, that burnt daub would be preserved within their sunken features had daub been used in the construction of these buildings.

There were also post ghosts surviving in the E ridge post-hole of both SFBs 1 and 31, which showed these posts had been squared off (West 1985, 15 and 31). There is occasional evidence in the form of post ghosts or soil staining within post-holes of SFBs (Tipper 2004, 71) and, in particular, within the post-holes of surface-laid or wall-post buildings ('halls') on other sites to show that substantial dressed timbers were used during the early to middle Anglo-Saxon period. There was clear evidence of timber ghosts within individual post-holes and foundation trenches of the wall-post buildings at, for example, the slightly later sites of Catholme (Staffordshire), Cowdery's Down (Hampshire), Thirlings and Yeavering (both in Northumberland) (Losco-Bradley and Kinsley 2002; Millett and James 1983; O'Brien and Miket 1991; Hope-Taylor 1977).

The evidence from these and other sites demonstrates the use of substantial, tangentially split timbers, although there is a considerable difference in size, and possibly in both materials and technology, between the structures at Cowdery's Down, at the highest level, and those found on more mundane settlements such as West Stow (Millett and James 1983). It seems reasonable to suppose that large, tangentially split oak was more likely to have been reserved for higher status buildings. At Brandon, for example, the surviving waterlogged timbers preserved in the base of post-holes and foundation trenches of several surface-laid buildings were generally of radially split oak, measuring *c*.0.20–0.25m long x 0.10m at their widest point. There was also some evidence of tangential splitting, generally confined to larger and probably higher status buildings (Darrah forthcoming). In Building 1094, which is interpreted as a barn rather than a dwelling, two of the posts were of non-durable ash, although all the others posts in this building, and the other with waterlogged remains, were of oak (Darrah forthcoming).

If SFBs were simply storage sheds and craft workshops, there is an argument to suggest that they might have been constructed using lower quality timber, reserving the better material for post-built halls. That said, there is good evidence in the carbonised timbers from SFB 3 and 15 to suggest the use of substantial timbers in their construction. The structural timbers, including the cellar and floor planks, and also wall boards of the Farmer's House reconstruction, were all made from green oak. The rafters in the Farmer's House were of non-durable softwood (coppiced ash poles), like the other reconstructions at West Stow, although they might equally have been made from split oak[iii].

Joints have been generally kept simple, using halved lap joints secured with oak pegs; structural stability is reliant on earth-fast post foundations. There is considerable evidence from the late Saxon period onwards for the use of this type of jointing (e.g. Goodburn 1992, 126; Darrah 2007, 61). Moreover, it has been suggested by Dixon (2002, 91) that the use of earth-fast posts pretty much precludes the use of sophisticated, pre-cut joints.

At West Stow, and other contemporary and also later Anglo-Saxon settlements, there is no evidence for the common use of nails or other metal fixings in buildings (e.g. Darrah 2007, 64–6; Malcolm *et al*. 2003, 155). At

Brandon, for example, there was evidence of peg holes, in pairs, near the ends of several fragments of timber boards (indicating the use of four auger sizes, 12–22mm in diameter), which together with the absence of metal nails and nail holes suggests that pegs were the main method of fixing structural timbers together (Darrah forthcoming). There was no evidence for the use of nailed fastenings on the London Waterfront before the 13th century (BG16) (Milne 1992). The use of iron nails in buildings appears to be associated with the introduction of timber-framing during the later medieval period.

Two iron spoon-bit augers (both from Layer 2), which might have been used to drill the holes for pegged fastenings, were found in the excavations at West Stow; the one measurable example was 22mm in diameter (West 1985, fig. 241 24–5). There was no evidence of pegging in the two SFBs destroyed by fire, but this is probably because no joints survived; the joints would have been weak points, subject to preferential burning and greater destruction because, compared to other parts, the surface area was larger and ventilation higher.

Pegged rectangular mortise and tenon joints have been used in this and the other reconstructions at West Stow, to secure the ridge beam to the top of the ridge-posts and the upper tie beams to the top of the corner-posts, as well as the door-posts to the floor joist and wall-plate. However, the type of standard rectangular mortise with central, two-shouldered tenon is not evidenced until the 13th century in London (BG14), where there is an unparalleled sequence of well-preserved structures on the waterfront that reflect changes in building techniques during the late Saxon and medieval periods. Rectangular 'long' mortises are unknown from pre-Conquest contexts in London, and elsewhere (Milne 1992). Base-plates with 'square' mortises have been found associated with 10th-century structures (TX1) although 'it seems that these early 'square' mortises simply accommodated the feet of the posts, dressed but not jointed' (Brigham *et al*. 1992, 15 and fig. 120). During the later medieval period, the long-pegged mortise and tenon joint provided more strength and stability than a simple lap or halved lap joint, and required more careful and complicated carpentry than earlier joints. This new type of joint was, therefore, crucial in the development of timber-framing, at which point buildings became fully framed and dependent on jointing for stability rather than on the force of gravity (Grenville 1997, 35–9). Indeed, without this type of tensioning joint, 'it is not possible to create a rigid structure that can be raised' (Darrah 2007, 61). The use of this particular type of joint at West Stow is, therefore, most probably anachronistic and a more simple type of wood joint would have been used to join timbers (Darrah 2007, 62–4 and fig. 3.20).

There was, however, no simple linear development of techniques (Grenville 1997, 37). Moreover, we cannot simply back-project the later Saxon techniques, assuming a linear progression of development from the earlier centuries (Dixon 2002, 91–3). The watermill (phase 3) at Tamworth is one of the few examples of timberwork preserved by waterlogging from the Anglo-Saxon period, dating from the mid to late 9th century AD. It provides evidence of a complex two-storey structure and mill pool employing sophisticated jointing of timbers, with a planked floor and walls (Rahtz and Meeson 1992). The foundation timbers (base-plates) for the floor of the wheel-house were held in place with a type of mortise and tenon joint (a tusked tenon that does not create a rigid joint like the later long-pegged or true mortise and tenon joint) while the foundation timbers of the mill-pool had sophisticated half-lapped joints (Rahtz and Meeson 1992, figs 82–3, 89 and 90). They had carefully cut seatings on their uppermost faces to take plank walls and mortise holes for vertical supports, suggesting they had shiplap boarding or substantial wooden walls with one plank sitting directly on another. The floor planks in the wheel-house had been cut away to fit neatly around the posts, each of which was notched over the foundation timbers to give support to the horizontal plank wall (Rahtz and Meeson 1992, figs 82, 84 and 86–7). In fact, in a number of aspects the Farmer's House reconstruction closely resembles the conjectural reconstruction of the millhouse at Tamworth by F.W.B. Charles, with six substantial posts (two of which supported a ridge beam), substantial base- and wall-plates, half-lapped together, planked floors and walls (Rahtz and Meeson 1992, figs 95–6).

IV. Sequence of reconstruction

(Fig. 2.2 and Plates 2.3–2.13)

The Farmer's House reconstruction measured 6.50m E to W by 5.00m N to S. It possessed a suspended floor over a plank-lined pit or cellar 4.00 x 3.00m in area and 1.60m in depth (the cut measured *c*.1.40m deep from the ground surface) (West 2001, 60–3). The building measured 5.00m in height at the ridge, with vertical walls 2.00m high along the N and S long sides of the building.

The Farmer's House was constructed as a six-post structure with large ridge-posts located centrally along the (short) E and W sides of the sunken feature, each 6.25m long x 0.18m square (Plate 2.4). These were located 4.20m apart and set in post-holes *c*.0.60m deep below the base of the cellar. The ridge beam, which measured 7.20m long x 0.18m square, was fixed on top of each ridge-post with a mortise and tenon joint. The top of each ridge-post had a central, two-shouldered tenon with rectangular mortises cut into the ridge beam. None of the posts had any form of preservative treatment, before insertion, to reduce the rate of fungal decay. However, the posts were placed on timber pads (i.e. flat pieces of oak inserted in to the base of each post-hole), to give greater stability but also to help protect the end-grain of each post.

The reconstruction had posts in all four inner corners of the lined pit. These corner-posts, each measuring 4.50m long x 0.18m square, were carried up to roof level to support the purlins, in reversed assembly, midway down the rafters. The term reversed assembly describes how a pair of posts across a building is joined by a tie beam, which lies directly on top of them (Hewett 1962, 250; Smith 1974, 239). It has been generally the preferred archaeological solution where post-holes are irregular as the roof or wall-plate, at the top of the wall, sits above the tie beam and is not in direct contact with the posts[iv]. However, it has been pointed out by Dixon (2002, 93–4 and fig. 3.83) that, in most wall-post buildings, there is 'a tendency for the posts in the walls not to form matching pairs'.

To counteract the spread of the roof, the corner-posts were stabilised by upper tie beams 2.75m above the ground, each 3.25m long x 0.18m square, that passed in

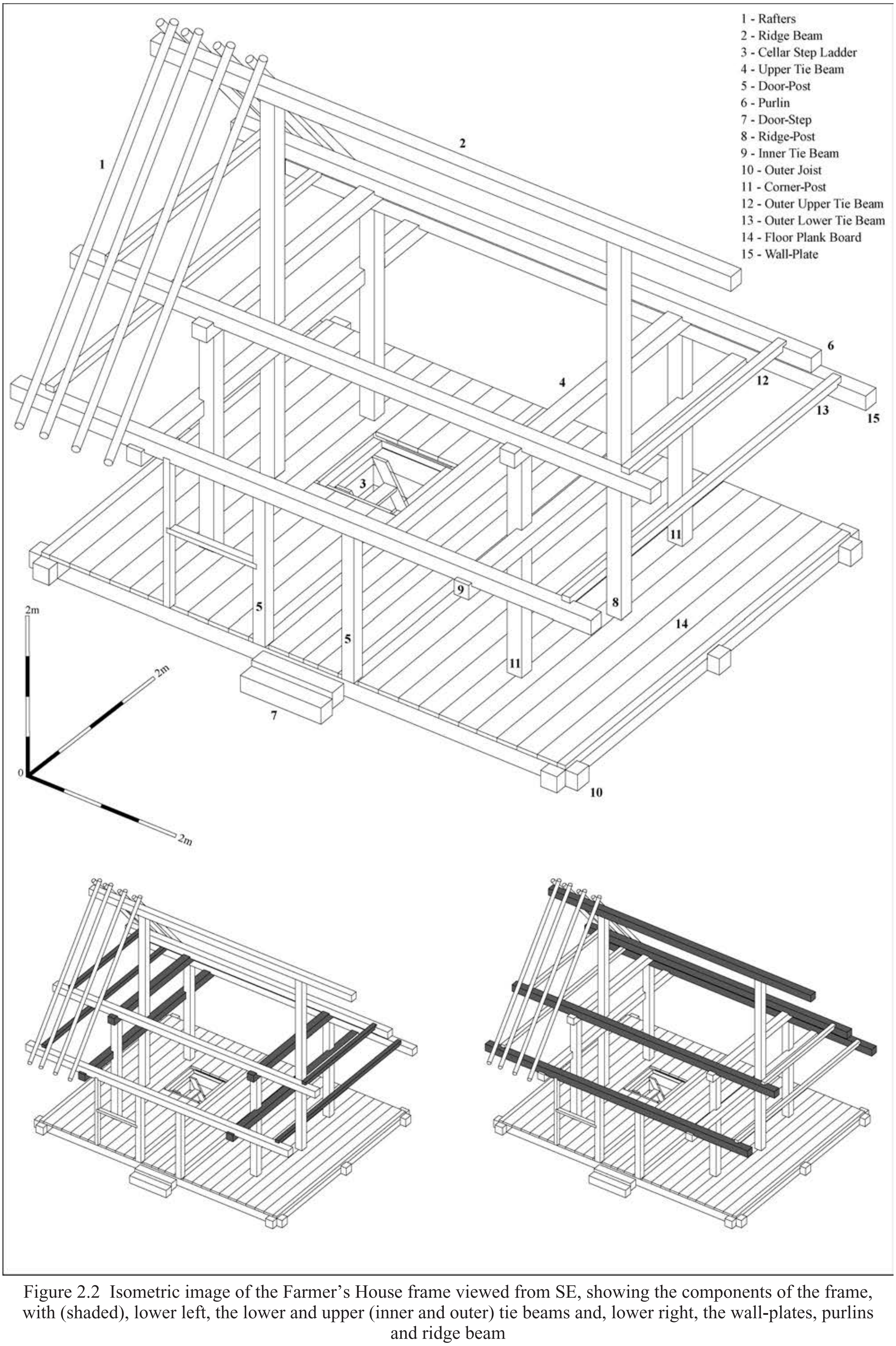


Figure 2.2 Isometric image of the Farmer's House frame viewed from SE, showing the components of the frame, with (shaded), lower left, the lower and upper (inner and outer) tie beams and, lower right, the wall-plates, purlins and ridge beam

Plate 2.3 The cellar during construction (viewed from NE)

Plate 2.4 After completion of the cellar, erection of the ridge-posts and infilling behind the cellar (viewed from NW)

Plate 2.5 The central posts and supporting joist. Notice already the accumulation of fine material around the base of the cellar

Plate 2.6 The floor joists (viewed from SW)

Plate 2.7 The suspended floor during construction (viewed from SE)

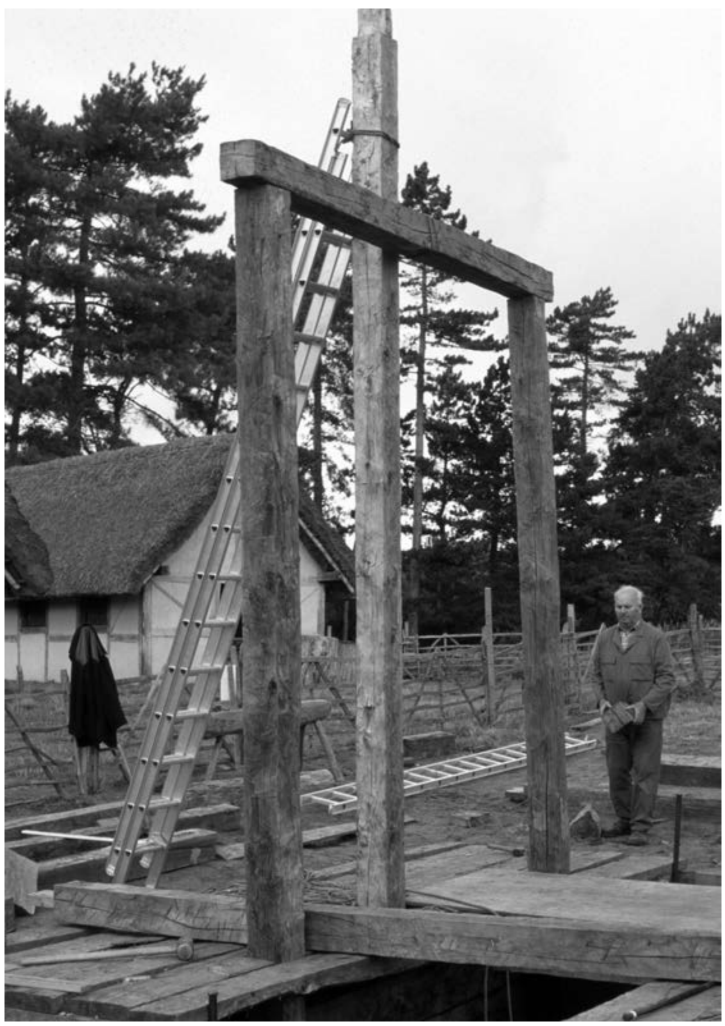


Plate 2.8 The frame during construction, showing the W end of the building after the ridge- and corner-posts have been erected and the upper tie beam fitted to the top of the two corner-posts (viewed from SE)


Plate 2.9 The frame near to completion, with upper and lower tie beams supporting the purlins and wall-plates respectively, the ridge beam fitted to the top of the two ridge-posts and with the two door-posts fitted centrally along the S side of the building (viewed from SE)


Plate 2.10 The completed frame during the fitting of the rafters. The rafters were attached to the frame before the wall cladding, which was then slotted under and around the rafters. However, the roof was thatched after the wall cladding had been fitted

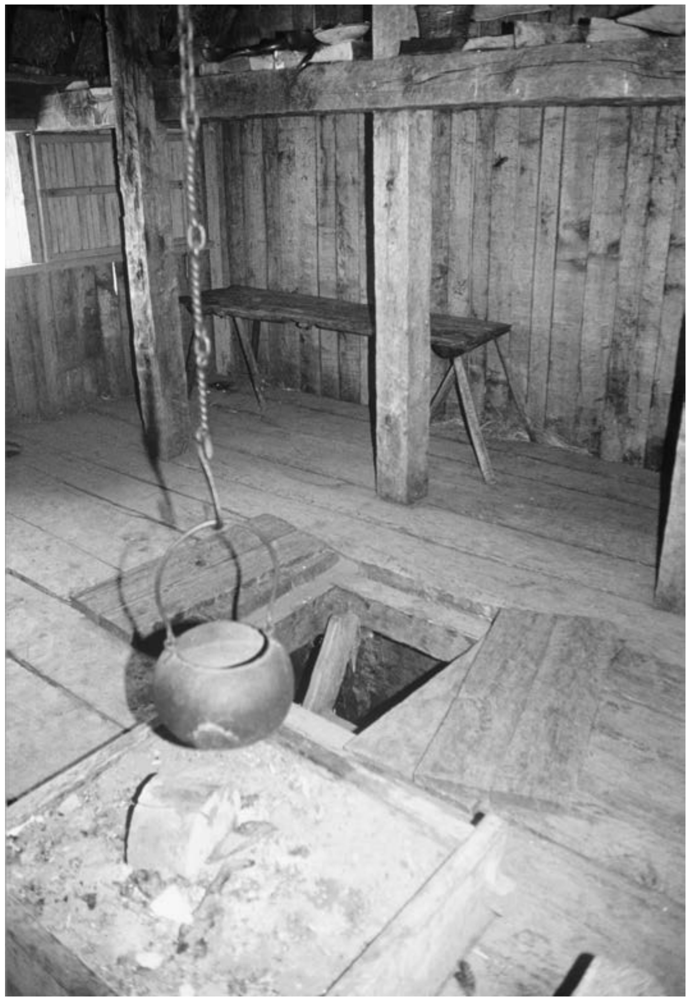


Plate 2.11 The trapdoor and step-ladder after completion, behind the central fire-box and with the cauldron suspended above it (viewed from NE). The image also shows a table in the SW corner, against the W wall of the building

Plate 2.12 The wall cladding being fixed to the E side of the building (viewed from E)

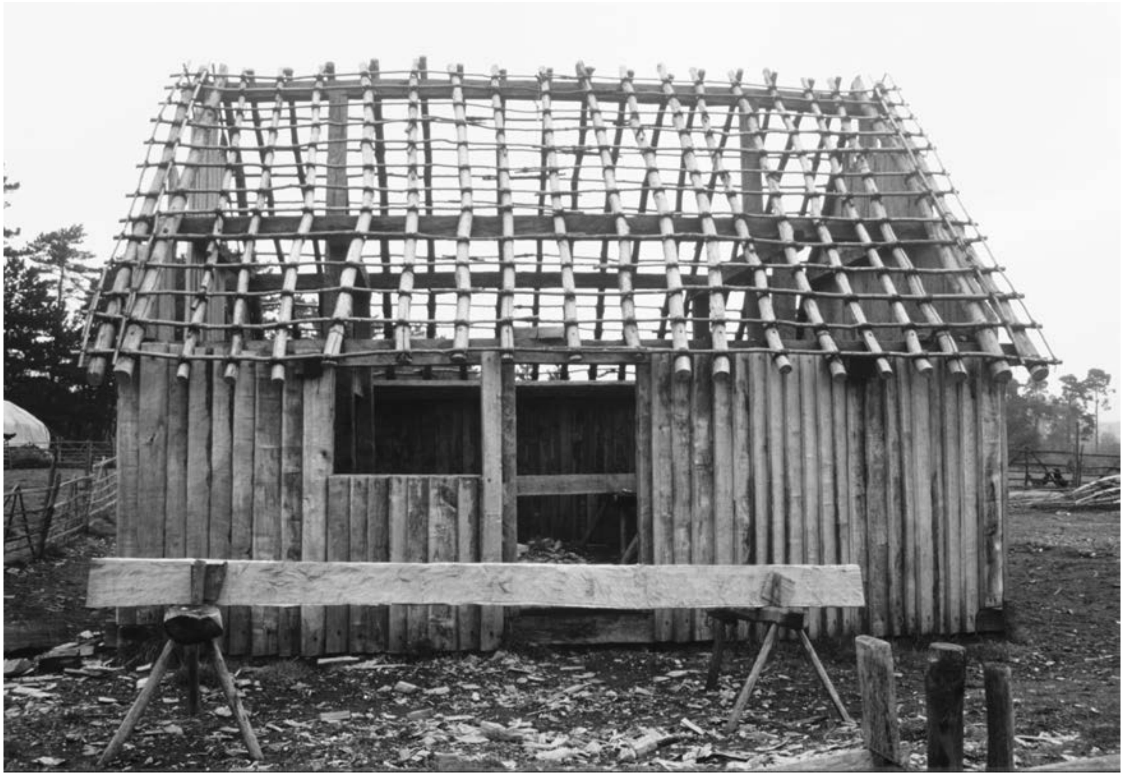


Plate 2.13 The S side of the building after the wall cladding has been fitted, with window and door openings, and after the hazel batons have been attached to the ash rafters with tarred twine. The board in front of the building is one of the final wall boards for the W wall

front of the ridge-posts (the corner-posts were offset in front of the ridge-posts). These were attached to the top of the corner-posts with a mortise and tenon joint (Plate 2.8). Each purlin, measuring 7.20m long x 0.18m square, was lap-jointed on to the top of the upper tie beams, directly above the corner posts (Plate 2.9).

Two lower tie beams, each 5.20m long x 0.18m square, spanned the width of the building, 2.00m above the ground surface. Each lower tie beam was lap-jointed and pegged onto the corner-posts and the ridge-posts, slotting between the staggered three posts (Plate 2.9). Lower purlins or wall-plates, each measuring 7.20m long x 0.18m square, were lap-jointed on to the top of, the lower tie beams. The S wall-plate was, in addition, fixed directly on the top of the two door-posts, and formed the top of the door and also the window frame. The tops of the wall boards were pegged to the outer side of the wall-plates.

The ridge beam, wall-plate and purlins were all carried beyond the line of the vertical posts and 1.60m beyond each end of the pit. Each timber weighed approximately a third of a tonne and the frame had an estimated total weight in the region of 4.80 tonnes (R. Lewis, pers. comm.). Additional beams (outer tie beams) were added at the ends to give further support (and for attaching the wall boards), which were half-lapped to, and supported on, both the wall-plates and upper purlins. Planks rested between the two lower tie beams on the W side of the building and formed a raised storage platform between the posts and the W wall.

The roofing consisted of modern wheat straw thatch (an estimated two tonnes) on ash and split ash rafters (Plate 2.10). There were 20 rafters, each *c*.3.90m long x *c*.0.10m in diameter, on either side of the roof. The rafters were bird-mouthed, and secured with pegs onto the ridge beam, purlins and wall-plates, with a roof angle of 45 degrees. Hazel rods or batons, each *c*.0.03m diameter, were tied to the rafters, and also the thatch straw was fixed to the batons, with tarred twine and twisted hazel spares (Plate 2.13). There were 13 rows of batons on either side of the roof.

The Farmer's House was unique amongst the reconstructions of SFBs with a suspended floor, in that it possessed a lined cellar below the floor. The lined cellar measured 4.00m long x 3.00m wide and was *c*.1.40m deep from the ground surface. There were four tangentially split boards along each side of the cellar, measuring *c*.0.36m wide x *c*.0.06m thick, and pegged at the corners (Plate 2.3). The boards were placed behind and outside the corner-posts, passing in front of the two ridge-posts. However, the lowest boards were set directly on the base of the pit and not in a trench like the original archaeological evidence within SFB 12. Two substantial posts, *c*.0.20m in diameter and left in the half-round, were inserted midway along the long sides of the pit to prevent the boards bowing inwards, although strictly there was no archaeological evidence from SFB 12 for deep post-holes at this location. These two posts were stabilised by a joist or tie 0.18m square across the width of the cellar, attached with mortise and tenon joints (Plate 2.5).

A pit considerably larger than the size of the actual cellar was excavated, mainly because the pit was dug through unconsolidated backfill. The cellar was then constructed as a free standing-box, before the posts were erected. The gap behind the lining was backfilled with the spoil and compressed around the sides, once the ridge-posts had been inserted behind the lining. The corner-posts were inserted afterwards, and after the central post along the long sides had been inserted.

The base of the reconstructed pit sloped down towards the centre; the base of the plank lining was up to *c*.0.10m above the lowest part of the pit cut. The base of the cellar was simply the natural sand, which had been very much disturbed during construction. There was no prepared or laid floor surface on the base of the pit. The cellar was often used for temporary storage, particularly during re-enactment events. However, nothing had been stored in the cellar immediately before the fire.

There were floor joists at ground level along all four sides of the building, each 0.20m square and half-lapped together at the corners, forming an interlocking base for the superstructure (Plate 2.6). The inner edge of each joist was located 1.05m away from the edge of the cellar along the gable sides and 0.80m along the long sides. The N and S joists, along the long sides of the building, measured *c*.6.30m long while the E and W joists, along the gable ends, were both *c*.5.20m long. These provided an internal floor area to the building of 32.50m^2, over twice the area of the lined pit (12.00m^2). There was also a central (E–W) joist (same dimensions as the outer joists), half-lapped to (the N side of) the ridge-posts and also lapped on to the outer joists at the foot of the walls.

Twenty-one floor planks spanned the internal area, N–S, each measuring 5.00m long x *c*.0.25–0.40m wide x *c*.0.10m thick[v]. The ends of the each plank were half-lapped and pegged on to the two N and S (E–W aligned) outer floor joists and also lapped and pegged onto the central E–W joist, above the ground surface (Plate 2.7). Sockets were cut out of the floor planks to accommodate the posts, which were wedged between floor planks to give the uprights additional rigidity, without the use of internal braces or external props.

The cellar was accessed through a trapdoor, located W of the central fire-box (Plate 2.11). The central E–W joist formed the S edge of the opening, with additional N–S joists between the N and central E–W joists forming the E and W sides and with an additional E–W joist between these forming the N side. The trapdoor was made from four short planks, aligned E–W (unlike the other floor planks). Eight iron rods, of varying lengths, were subsequently threaded N–S through the planks and a secondary sheet of plywood was fixed to the underside to give additional strength to the trapdoor.

There was a three-stepped ladder down into the cellar, which rested against the W joist of the trapdoor (Plate 2.11). There was no evidence of an entrance down into the base of the sunken feature of SFB 12 and, therefore, this was a practical means of entry that had no impact on the sides, which also left no evidence on the base of the sunken feature.

The non-load-bearing walls consisted of overlapping radially split boards, each with a simple rebate on the thick edge. These triangular-sectioned planks (151 planks in total), each *c*.0.25m wide x 0.10m thick (max.), were pegged onto the frame — to the outer side of the joists at the base and to the lower purlin/wall-plate along the long sides and to the outer tie beams on the gable ends (Plate 2.12). Along the E and W gable-end walls of the building, two boards were required to span the distance between ground level and eaves, divided at the level of, and pegged to, the lower outer tie beam.

The door was located centrally along the S side of the building (Plate 2.13). The door-posts, 0.95m apart, were fitted to the floor joist and the wall-plate with mortise and tenon joints. The door hinges were fixed into sockets cut into the wall-plate and the outer joist on the E side of the doorway. Two blocks of timber acted as doorsteps, placed against the joist. A large rectangular window with sliding shutter, 1.00m wide x 0.80 high, was fitted on the S side of the building, to the W of the door (Plate 2.13). The W side of the window frame was formed by the insertion of a vertical timber between the floor joist and the wall-plate; the base of the frame was formed by a horizontal timber between this and the door-post. The wall-plate formed the top and the W door-post formed the E side of the frame. The window shutter had 25 vertical (pine) slats (each 0.63m long x *c*.0.05m wide x 7mm thick), fixed in a frame that slid towards the W in runners at the top and base.

V. Internal features and furniture

There was a detailed inventory of the building's contents, and the location of the objects within it, and also how and with what they were made. These comprise, directly on the suspended floor:

- Fire-box, located roughly centrally within the building, although to the N of the ridge line, in line with the doorway (Plate 2.11). It consisted of a rectangular box made of thick oak planks, measuring *c*.0.85m x 0.75m in area by 0.30m deep (based on the example in the adjacent Living House). Flint blocks in the base of the box were covered with a layer of sand, with a layer of tile fragments on the surface forming the base for the hearth. There was an iron fire-dog, *c*.0.50m long, standing vertically in the fire-box. The chain for the cauldron was suspended above the fire-box from an ash pole that lay between, and resting on, the N purlin and the E upper tie; the cauldron itself was not in the building at the time of the fire (Plates 2.11 and 2.14).
- Bed in the NE corner (behind the NE corner-post), low (crude) bed in the SE corner (three planks pegged together) (Plate 2.15).
- Small table and bench along the S wall, immediately below the window.
- Chair in the SW corner.
- Long table and long bench in the NW corner, along the W wall (from the corner to the ridge-post)
- Small bench along the N wall, next to the chest.
- Fire extinguisher in SW corner (behind chair).
- Several wooden stools.
- Two wooden chests, one along the N wall (with leather straps) and the other along the S wall (with metal straps) (Plate 2.16).

With the exception of the fire-box, all the furniture stood against the walls of the Farmer's House, outside (i.e. not directly above) the area of the lined pit.

On the W platform (Plate 2.17):

- one complete and several semi-complete pots in the S part. None of the vessels had any contents.
- (at least) two wicker baskets to the N of the pots.
- fish trap (under the eaves in the space between the NW corner-post and the roof).

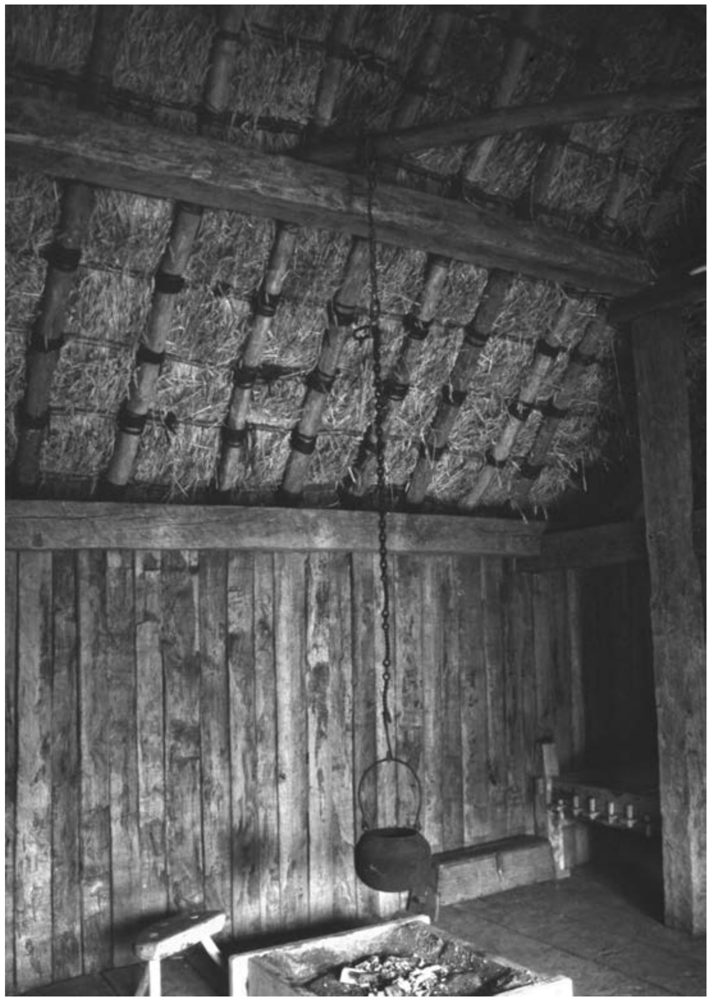


Plate 2.14 The interior of the building, showing the cauldron suspended above the fire-box (viewed from the SW)

Plate 2.15 The interior, E end, showing the shield fixed above the lower tie beam, to the E ridge-post, with a bed in the NE corner of the building

Plate 2.16 The chest within the Living House, similar to that destroyed in the Farmer's House

Plate 2.17 Interior, W end, showing the shelf above the lower tie beam with various pottery vessels and wicker containers, including a fish trap, with an antler tine hanging from the NW corner-post, fishing net from the upper tie beam and sacks suspended from the roof

- ferrous chain.

Hanging at the W end:

- fishing net hanging from the upper tie beam, antler tine from the top of the NW corner-post hanging from a peg just below the purlin.
- two sacks from the roof.

Hanging from the N wall:

- several wall hangings.

Hanging at the E end:

- shield hanging from the E ridge-post, above the E (N–S) lower tie beam (Plate 2.15).
- spear fixed horizontally to the E (N–S) upper tie beam, with the spearhead at the N end, i.e. pointing N.

In addition, two log piles were stacked and stored against the S wall, on both sides of the doorway, below the eaves and outside the building (Plate 1.5).

Endnotes

i SFB 12 was excavated relatively early in the eight year excavation, during the second year in 1966. In later years SFBs were recorded in spits and by quadrant and with the distinction between lower primary fill and upper post-hut fill.

ii One recent design, however, at Higham Ferrers, Northants, shows the axial posts extending only to the level of the suspended floor, to support a central floor joist (Hardy *et al*. 2007, 188–91 and plate 5.1)

iii The Sunken House does, however, employ split oak rafters. The experiments have clearly demonstrated how the softwood rafters and batons are prone to woodworm attack.

iv In contrast, the term normal assembly describes how the roof or wall-plates were attached to the top of the posts with the tie beams, preventing lateral movement, on top of them (Smith 1974, 241). This method of construction is associated with the use of the sill.

v Several of the boards, however, were split in two and spanned only half the width of the floor, between the outer and central joists.

3. The Physical Remains

I. Introduction

In the following chapter, a detailed discussion is undertaken of the surviving physical evidence provided by the excavation of the burnt remains of the Farmer's House.

The evidence from the physical remains is supplemented by the images taken during the fire. The final stages of the fire were recorded by the Village Manager who was called to the site just after 03.00hrs by which time the Suffolk Fire Service was already in attendance and the fire was well advanced. It is difficult to estimate precisely when the fire started but presumably during the early hours of 19 February 2005.

Plates 3.1 and 3.2 were taken over a period of an hour and show the final stages in the sequence of destruction, after most of the superstructure had already been destroyed. Although the roof and most of the wall boards, together with wall-plates, purlins, tie beams and ridge beam, had all collapsed before the fire was photographed, the position of many can be discerned on the ground, showing exactly where some of the major timbers fell, and in some cases the order, of collapse. Many of these collapsed timbers were subsequently destroyed, either because they fell into the cellar pit, and fuelled the intense fire within the pit, or because they continued to burn where they had collapsed on the surface, and eventually burned completely away. By 04.30hrs nearly all the superstructure had collapsed, apart from the four corner-posts, which were on the point of collapse, and the two door-posts. The images taken during the following days show that the fire smouldered for at least a further 24 hours, causing further destruction after the main event. Sections of the outer floor joist (for example, along the S side of the building, to the W of the door), photographed the morning after, during daylight, were subsequently completed destroyed as a result of this process.

The images of the fire have been carefully studied, in conjunction with the surviving remains, to further our understanding of the sequence of destruction. They also enable a number of charred, fragmentary and otherwise unidentifiable remains to be identified as specific structural timbers. In addition, an extensive photographic record was made of the remains during the interval between the fire and the excavation, and these are also an aid to interpretation and form a record of changes to the remains between the fire and excavation.

Plate 3.1 Photograph taken during the fire, at 03.30hrs, from the NW corner of the building. Only the posts and several wall boards remain vertical. The wall-plates lie immediately above the outer floor joists, having collapsed. The N wall-plate is sealed below several structural timbers, probably the lower tie beams, and also several wall boards. The two purlins lie E–W across the cellar, resting above other parts of the frame that have also collapsed. Wall boards along the W gable side, which have fallen outwards, lie burning on the ground

Plate 3.2 Photograph taken during the fire, at 04.24hrs, from the NW corner of the building. The E ridge-post is recorded during the moment of collapse, falling SW towards the doorway. All four corner-posts and both door-posts are still upright, although the NE corner-post has a precarious lean towards the N. The fire-box can be still distinguished on the suspended floor, immediately to the left of the NW corner-post

Plate 3.3 The Farmer's House remains taken from above (viewed from N) on 24 March 2005

II. Deformation processes between the fire and excavation

The excavation of the burnt remains was undertaken four months after the fire. The project design for the investigation was approved in June 2005. A major aim of the project was to enhance public engagement with, and understanding of, experimental archaeology and so the excavation was scheduled for July to coincide with National Archaeology Week.

After the fire the site was fenced off to prevent human (and as much as possible animal) disturbance of the remains (Plate 3.3)[i]. Several (unburnt) sticks had clearly been thrown in by visitors, while (unburnt) straw had blown onto the site, from re-thatching of an adjacent building (between April and June). Several of the burnt timbers had been dislodged, presumably by staff.

A certain amount of animal disturbance (principally rabbit and mole) occurred, in particular, during the two weeks preceding the excavation (the first burrows were recorded on 24 June) (Plate 3.4)[ii]. Within the pit, several burrows were dug along the N (W) and S (W) sides of the pit, at the base of the exposed pit side and level with the top of the collapsed deposit; the clean sand from the burrows tailed down the collapsed deposit. Outside the pit, there was a large burrow on the SW side, below the location of the window but outside the wall-line, and also several mole hills. During the excavation (and presumably during the four months between the fire and excavation), each morning the remains were found to be criss-crossed by animal tracks, evident in the soft sand, which showed the amount of animal traffic across the remains each night; rabbit burrows continued to be dug most nights within the pit during the excavation.

The photographs, and regular observation, enabled a qualitative assessment to be made of the changes — the immediate post-depositional processes — that took place during the intervening four months between the fire and excavation.

There were some considerable changes to the remains during the period between the fire and excavation and there is some loss of detailed and subtle information relating to the fire. This would probably not survive in the archaeological record either and it has been, therefore, useful to document the loss of this evidence. Prominent ridges of fine sand, for example, that had accumulated below the suspended floor on the protected ground surface below the doorway, were clearly visible for at least a month after the fire (with charcoal fragments in the troughs) and they were still just visible on the images taken on 24 June. These had been completely flattened (by the elements but also as a result of animal disturbance), and removed by further side collapse, by the time of the excavation.

The upper, unconsolidated sand sides of the pit (following the collapse of the cellar lining) had also suffered gradual erosion — these sides were burnt during the fire but, as a result of erosion, most of the burnt outer face (<0.05m thick) had collapsed down into the pit; this process began immediately after the fire, exposing unburnt material. Large blocks and lumps of sand that had collapsed into the pit from behind the cellar lining during the fire, were gradually rounded and reduced in size. However, this process continued during the four month period, as new blocks of sand broke away from the (near) vertical upper sides, which also served to increase the size of the pit (although it was not significantly increased). During excavation of the pit, there was also ongoing side collapse particularly as the material was removed from the

Plate 3.4 The extent of burrowing on 24 June 2005 (viewed from S). There is one burrow outside the wall line on the S side of the building, below the location of the window, and another on the N side of the pit, level with the top of the side collapse

base to expose the lower part of the sides. This resulted in the outer floor joist, along the S side of the pit below the doorway, being undercut; the joist was left *in situ* after the excavation and it subsequently collapsed into the pit (by the end of September 2005) as a result of further erosion and side collapse.

Fragments of charred material, generally <0.05m in size, brought down from the surface (presumably by wind, rain and gravity), accumulated in the central base area and in the corners of the pit. There were several specific bad-weather events, for example, one torrential rainstorm on 3 June, causing erosion gullies to form that cut into the exposed pit sides and carried surface material down into the base of the pit. In general, wind and rain erosion together had the effect of rounding off and flattening the soft sand remains of the pit.

Most notably on the ground surface, outside the footprint of the building, the prominent piles of ash that were recorded along the long sides of the building after the fire, *c*.0.25m high, which were the remains of thatch that had simply slipped off the roof and smouldered on the ground, had been flattened and degraded as a result of wind and rain erosion. Some piles had completely disappeared leaving bare soil, and must have simply been blown or washed away, and further fragmented, leaving thin layers *c*.0.03–0.04m deep (see below). In addition, there was a 'halo' of charcoal fragments on the ground to the E and SE of the remains, which had clearly been taken by the wind; this halo survived for only a short period of time on the ground surface after the fire.

While the thatch ash deposits had been almost completely destroyed in four months, the fragmentary charred boards on the ground surface had also begun to deteriorate. The outer charred surfaces had begun to weather and fracture away from the surviving timber, as a result of wind and rain but also as a result of plant colonisation which had exploited the cracks within the surface char layer.

The process of plant re-colonisation also took place around the remains, from the edge of the burnt ground surface inwards, and several plants took root within the pit. Unfortunately, the process was not systematically recorded before excavation although the plant fauna was recorded afterwards (Ballantyne in Chapter 5).

III. Evidence of the superstructure

The burnt remains occupied an area *c*.14.00 x 11.00m, which is considerably larger than the footprint of the reconstruction (6.50 x 5.00m) (Figs 3.1–3.3, Table 3.1 and Plate 3.3). In the centre, there was an irregular-shaped and partially infilled pit, which had partially burnt sides. Within the pit, with the exception of the remains of a small number of charred floor planks on the base and the lower *in situ* part of the posts, there were only several fragments of heavily charred timber that could be related to the above-ground superstructure, although there were also many small unidentifiable fragments.

The pit, which was the remains of the cellar, was surrounded by burned and scorched ground ranging from brown and black to bright orange in colour — although the soil discoloration was only several centimetres deep — as well as bare ground where the vegetation had been burnt, as well as the scattered and fragmentary remains of the superstructure. These remains consisted of charred and partially charred timber fragments, unidentifiable charcoal fragments and spreads of ash.

There was very little surviving evidence to indicate how the superstructure had been constructed or the quantity of timber that had been used, or to indicate the substantial size of the structural timbers (that individually weighed up to a third of a tonne), with the exception of the surviving wall boards and several post fragments which had fallen outwards, as well as the remains of the outer floor joists. A number of fragments could be identified to specific structural elements of the building, although specific elements of the frame were identified only as a result of the information provided by the images taken during the fire that showed where a number of the major structural timbers fell (Table 3.2 and Plates 3.1 and 3.2).

There was also evidence for the nature of the roof on the ground outside the pit, in the form of thatch ash deposits, several charred rafter fragments and several partially charred fixings.

Evidence of the frame

There was only a small number of fragments that could be positively identified from the framework on the surface around the sunken feature. Within the pit, there were several small fragments of timber (which were clearly not the remains of wall boards) that had probably collapsed down from the superstructure, above floor level.

The wall-plates, purlins, tie beams and ridge beam, together with the roof and most of the wall boards, had all collapsed before the fire was photographed. A number of these burning timbers are identifiable on the ground, and supported across the top of the blazing cellar in the images. All six posts were still standing when the first images were taken, although the top of the posts had burnt off and the ridge-posts, in particular, were leaning towards the W (Plates 3.1 and 3.2).

Main Identified Timber Element	*% surviving*
Outer Joists (4)	50
Central (E–W) joist (1)	0
Central (N–S) joist (1)	14
Ridge-posts (2)	28.6
Corner-posts (4)	29
Central (long side posts)	39
Door-posts (2)	16.3
Ridge Beam	0
Wall-plates (2)	3.5
Upper Purlins (2)	5.9
Tie Beams (4 lower, 4 upper)	0
Floor (21 planks)	3.05
Walls (388m of boarding)	11
Cellar lining (16 boards)	50
Rafters (40)	1.3
Total (surface and cellar)	**17**

The proportion varies from 50% for the cellar lining to 11% for the walls (and from 19% for the E and W gable walls to 3% for the N and S long walls). The estimate for that part of the structure above floor level (based on ridge-posts, corner-posts, door-posts, ridge beam, wall-plates, upper purlins, tie beams, wall boards, rafters) is 5.9%; with the exception of a single piece of door-post within the cellar pit, all these remains were from the ground surface

Table 3.1 Estimated surviving quantity (%) of main timber elements (original number of each element in brackets)

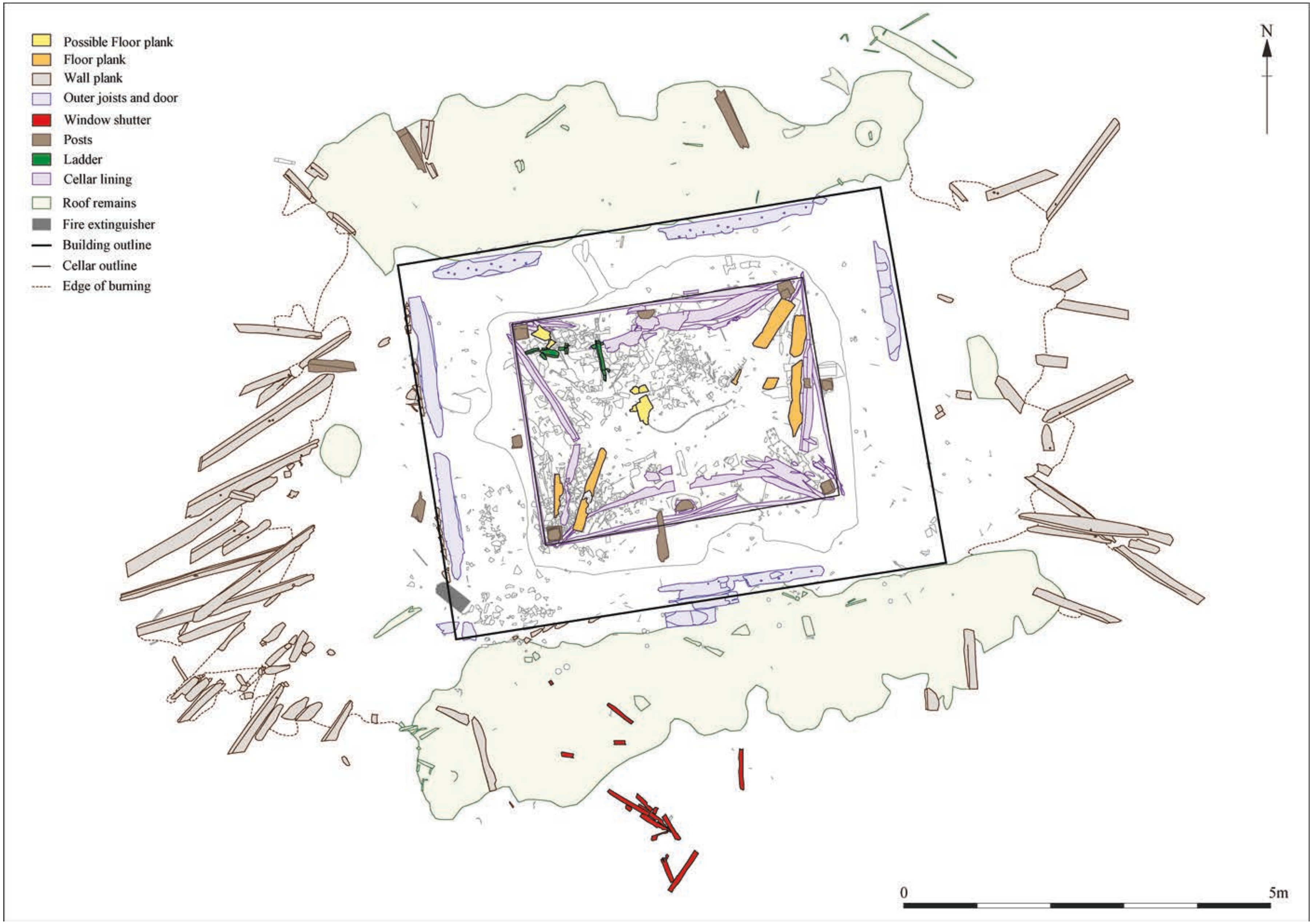


Figure 3.1 Plan of the Farmer's House remains. The limit of burnt ground is indicative because there was no clear edge

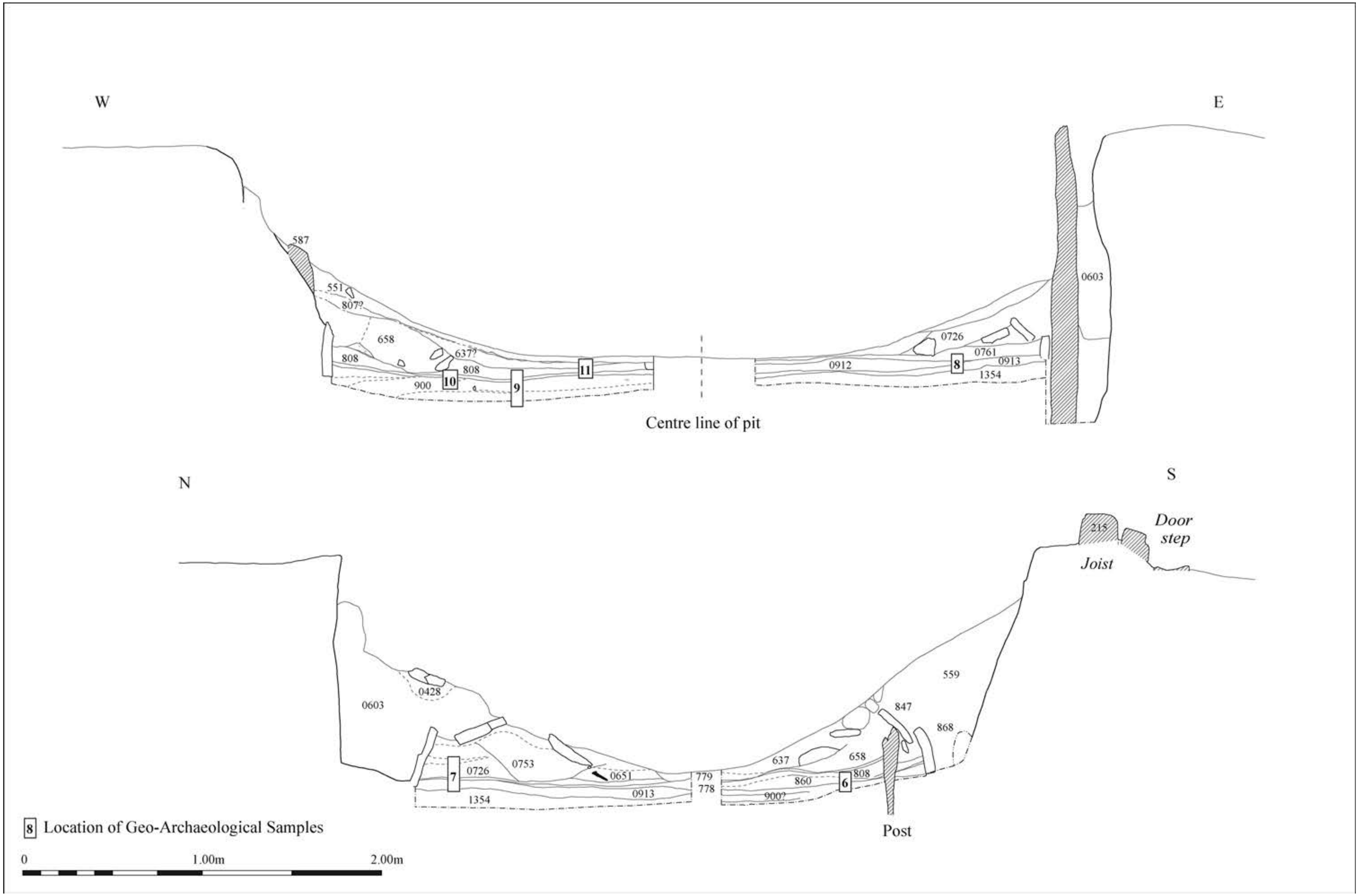


Figure 3.2 Sections across the cellar pit, E–W and N–S (see Table 3.1 for context descriptions)

Context Number	*Description*
343	Mixed orange and yellow burnt sand surrounded by burnt flints. Remains of fire-box in NE quadrant of cellar pit
383	(Base of) E ridge-post
418	Uppermost surviving collapsed board of the cellar lining along S side of the pit in the SW quadrant. The board forms a division between unburnt brown sand (to S), which has collapsed down from behind the original lining, and burnt orange sand (N)
423	Mixed collapsed orange and yellow burnt sand layer (containing charcoal fragments) in NE quadrant. The uppermost layer of collapse in the NE quadrant, and the result of erosion and side collapse between the fire and excavation
551	Orange burnt sand behind cellar lining along W side of pit in SW quadrant
559	Brown unburnt sand behind cellar lining along S side of pit in SW quadrant
580	Collapsed (second lowest) board of cellar lining along the N side of pit in NE quadrant. Part of the same (collapsed) board as 649
581	Charred timber along N side of cellar pit, aligned roughly NNE-SSW and tipping down into the pit (above collapsed deposit from behind cellar lining), *c.*0.35m long x 0.13m wide
587	(Base of) W ridge-post
603	Brown, and largely unburnt, sand in NE quadrant. Above the collapsed cellar lining and appears to have collapsed in from behind/ outside the cellar lining (i.e. backfill around the original lined cellar)
637	Orange burnt sand in SW quadrant of cellar pit, with patches of brown and patches of yellow sand, some (low) small charcoal fragments. Probably the result of side collapse from behind the upper cellar lining (i.e. not material that has accumulated during use)
644	*In situ* lowest board of cellar lining along S side of pit in SW quadrant
646	Probable collapsed board of cellar lining along S side of pit in SW quadrant, lying flat and roughly E-W 0.10m to the N of board 418
647	Small section of collapsed (second lowest or possibly second highest) board of cellar lining on S side of cellar pit, wedged behind (base of) central post 1063. Heavily charred on inner-facing side and lightly burnt on outer side. Same as 1064 and possibly 418
649	Collapsed (second lowest) board of cellar lining along the N side of the cellar pit in NE quadrant
650	*In situ* lowest board of cellar lining along N side of pit
651	Mixed orange and black burnt sand, and also grey ash, layer in NE quadrant
652	(Pale) Grey burnt sand layer with frequent loose charcoal fragments in SW quadrant
655	*In situ* lowest board of cellar lining along E side of pit in NE quadrant
658	Dark grey-brown (slightly burnt?) sand in SW quadrant, probably similar to 637
726	Dark brown and black burnt sand under collapsed (second lowest) board of cellar lining along the N side of pit in NE quadrant
753	Layer of burnt charred material (thatch?) and charcoal directly below collapsed (second lowest) board of the cellar lining along the N side of the pit in NE quadrant
761	Thin dark brown burnt sand layer, with patches of black sand overlying it, across the base of cellar pit in NE quadrant. Appears to be remains of highest accumulation deposit below the suspended floor
767	Layer of grey sand and ash with moderate charcoal fragments. It surrounds and extends below charred floor planks [764], [765] and [788] on E side of NE quadrant. Probably collapse rather than accumulation deposit
777	Fine pale grey (blotched black) sand layer in SW quadrant. Possibly the uppermost (*in situ*) accumulation layer or lowest collapsed layer. Same as layer [778]
778	Pale grey ash layer in SW quadrant. Possibly the uppermost (*in situ*) accumulation layer or lowest collapsed layer
779	Orange burnt sand layer in centre of cellar pit in SW quadrant. Part of destruction/collapse, rather than construction/accumulation during use
781	Collapsed (second lowest) board of cellar lining along W side of pit in SW quadrant. Same as 1004
788	Charred floor plank on base of cellar pit in NE quadrant, above layer 767
789	Charred timber, aligned roughly NNE-SSW, 0.16m long (min.) x 0.14m wide, in NE quadrant. Possibly the remains of a collapsed floor plank
807	Very dark grey-brown burnt sand below collapsed cellar lining along W side of pit in SW quadrant. Probably the result of collapse from behind lining
808	Very fine black sand layer on base of pit in NW and SW quadrants containing carbonised organics and pencils, and other finds (including pot-sherds) embedded within it. (Upper) accumulation layer that formed on the base of the cellar below the suspended floor. The accumulation is greatest against the (*in situ*) lining, sloping down into the centre of the pit
829	Charred structural timber aligned N-S and tipping down into the pit and above layer 753, in both NE and NW quadrants. Possibly part of the central floor joist between the two central (N-S) posts
837	*In situ* lowest board of cellar lining along W side of cellar pit in SW quadrant
860	Dark red-brown burnt sand in SW quadrant. Probably the result of accumulation during use and/or possibly during construction
868	Brown unburnt sand behind (outside) lowest (and *in situ*) cellar lining 644 in SW quadrant
869	Nail within layer 651 in NE quadrant
900	Mixed (dirty) yellow-brown (and grey) sand on base of SW quadrant (at first mistaken as clean natural below the base of burning). Patches/thin lenses of more compact dark brown sand *c.*0.05m thick and also thin bands of yellow sand *c.*0.04m thick. Very few finds, including uncharred wood fragments. Disturbance/trampling deposit during construction, and probably accumulation below the floor, combined with intermittent cleaning and also trampling in the cellar; 860, directly above, might have been originally part of the same layer
912	Reddened burnt sand layer across the base of the cellar pit in NE quadrant. Accumulation deposit below the suspended floor
913	Mixed compact dark brown sand and dark yellow sand layer on base of cellar pit in NE quadrant. Possibly a trample layer at base of cellar, during construction and/or use
1004	Collapsed (second lowest) board of cellar lining along W side of cellar pit in NW quadrant. Same as/part of board 781

Context Number	*Description*
1063	Charred (base of) central post along S side of cellar, located in front of the plank lining. That part set in the ground, which was uncharred, had suffered considerable decay and there was an outer layer of dark brown organic rich material mixed with sand, *c*.0.02m thick, surrounding the post base
1064	Small section of collapsed (second lowest or possibly second highest) board of cellar lining on S side of cellar pit, wedged behind (base of) central post [1063]. Probably same as/part of board [418]. Heavily charred on inner-facing side and lightly burnt on outer side
1354	Disturbed yellow sand under (but subsequently shown to be same as) 913 in NE quadrant, overlying undisturbed natural. Layer probably relating, and disturbed during, construction

Table 3.2 Summary of contextual information for sections across the cellar pit (Fig. 3.2)

Wall-plates

There was no definite evidence of the two substantial wall-plates but several short lengths of timber might originate from the S wall-plate. The images of the fire suggest that the N wall-plate dropped straight down onto the outer (E–W) floor joist but there was no surviving physical evidence of it. The S wall-plate broke into separate pieces above the door frame. The images show the E end of this wall-plate resting against the E door-post, before its collapse. A short length of charred timber, *c*.0.30m long, is possibly the remains of the W end of this wall-plate, located on the same alignment as, and directly below the position of, the wall-plate in the SW corner. Alternatively, it could possibly be the end of the S floor joist. There was also a short length (possibly one end) of heavily charred timber, *c*.0.20m long, located on the ground surface *c*.1.20m to the N of the line of the S floor joist, immediately W of the door. It is probably part of the wall-plate from above the door but it could be part of a door-post.

Purlins

A short length of charred timber, *c*.0.65m long, is probably the remains of the W end of the N purlin. It represents the only surviving and identifiable evidence of the two purlins. The W (cut) end of this charred timber was *c*.1.50m from the end of the *in situ* outer joist. However, originally, the purlin extended only *c*.0.45m beyond the wall-line (i.e. it fell towards the W by over 1.00m), which indicates that at least this part of the superstructure collapsed towards the W. The charred purlin also appeared to lie across the remains of a wall board which fell outwards from the W gable end of the building. This stratigraphic relationship demonstrates that the wall board fell before the purlin.

The images of the fire show that the N purlin fell on the S side of the N corner-posts and was lying ESE–WNW across the pit, resting on top of the fire-box between the NW corner-post and the E ridge-post and also on top of at least one tie beam. The S purlin is less clear but appears to be in a similar stratigraphic position, located on the N side of the two corner-posts, which shows it also fell inwards.

There was also a short length of heavily charred structural timber, *c*.0.40m long (max.), located on the ground surface *c*.0.15m outside the wall-line on the W side of the building, aligned NNE–SSW *c*.0.55m S of the central axis of the building. This is possibly the remains of the W end of the S purlin, but alternatively it could be a fragment of the ridge beam.

Tie beams

There was no surviving evidence for the tie beams. The lower tie beams at the W end of the building are visible in several images of the fire. In Plate 3.1 the N end of the main tie beam appears to be resting across the collapsed wall-plate and sloping down into the cellar pit, pinned below the N purlin which must have collapsed on top of it. The lower outer tie beam, onto which the gable wall boards had been pegged, is apparently resting across the top of the collapsed N wall-plate, although it is below the S wall-plate.

The two main (lower) tie beams presumably collapsed with the wall-plates because the latter were supported by the ties, and must have fallen vertically because all the posts, to which they had been half-lapped and wedged between, were still upright. The tenons at the top of the corner-posts must have snapped off, in order to explain the collapse of the upper tie beams, which were fitted onto the top of the corner-posts with mortise joints.

Ridge beam

There was no clear evidence of the ridge beam, which had already collapsed before the first images of the fire were taken. A heavily charred fragment of structural timber, *c*.0.20m long, was located on the E side of the remains, *c*.0.50m outside the wall-line and *c*.0.40m S of the central axis. This fragment could be part of the ridge beam. On the W side of the remains, a short length of charred structural timber, *c*.0.55m S of the central axis, could be part of the ridge beam or it could be a fragment of post or purlin (see above).

Posts

The six main posts, and the two door-posts, were the last parts of the superstructure to collapse, after all the wall boards had fallen. The images of the fire show that both ridge-posts collapsed before the corner-posts and also the door-posts (Plate 3.2); the evidence for the door-posts is discussed in the section on the entrance. The W ridge-post collapsed first, towards the N, followed by the other, which fell towards the SW *c*.20 minutes later. The last image taken during the fire, at 04.37hrs, shows that the SW corner-post was the first of the corner-posts to collapse. This post fell towards the SE; the post is clearly visible at ground level, lying across the top of the collapsed S wall-plate and to the W of the door that was still marked by both door-posts.

With the exception of the lower part of each post, which survived *in situ* (see below), the upper part of only two posts was identified — the W ridge-post and also the NE corner-post (Fig. 3.4). The surviving percentage of the

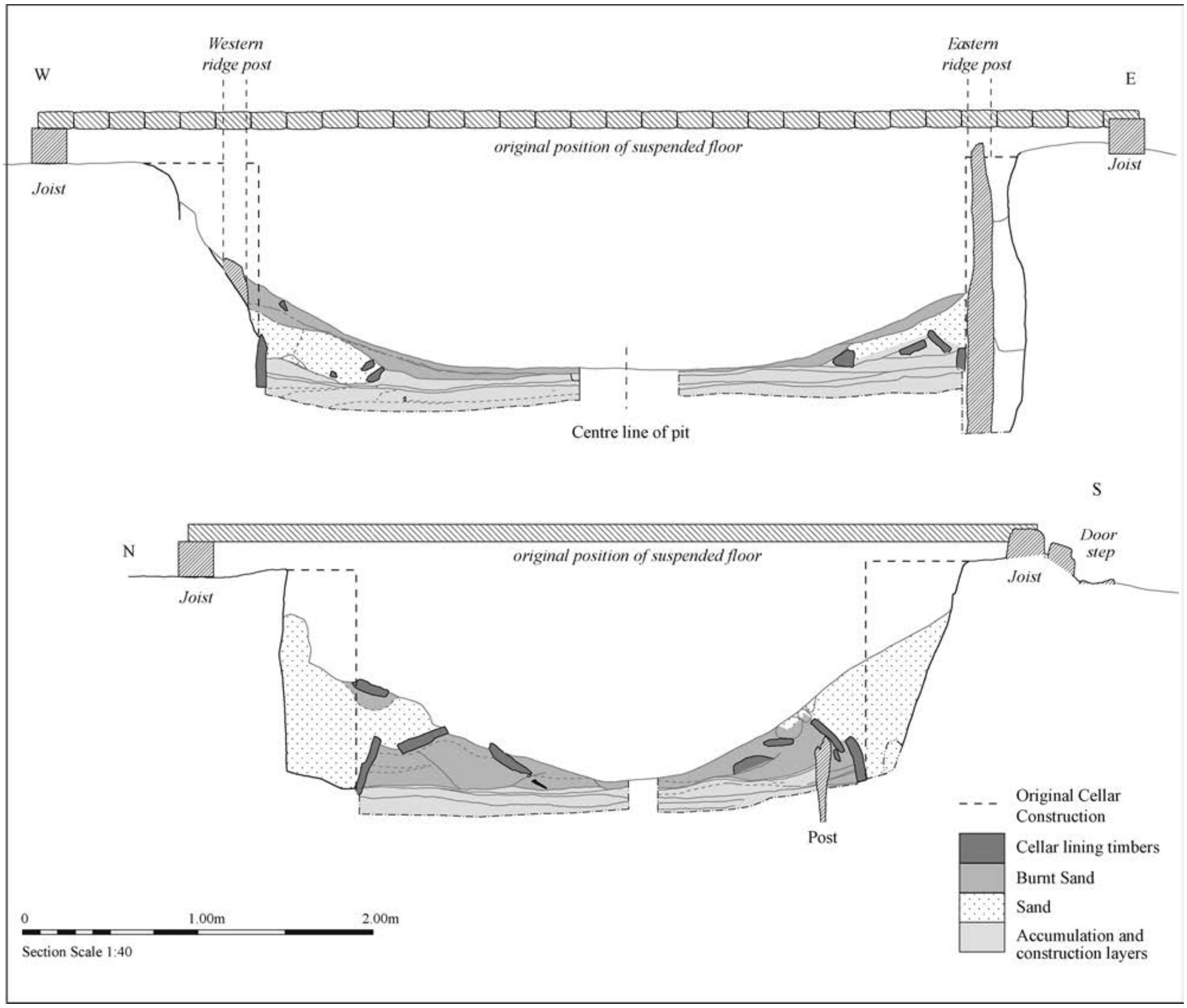


Figure 3.3 Interpretative sections across the cellar pit, E–W and N–S

six posts is calculated at 29%, of which 24% (7.38m) was in the form of *in situ* post bases, while the remaining 5% consisted of the upper ends of two posts (1.50m in total) on the ground surface beyond the wall-line of the building.

The upper end of the W ridge-post survived as a short length of partially charred timber, *c*.0.65m long. This fragment was located on the ground surface *c*.4.50m from the *in situ* base of the original post and beyond the NW corner of the building (*c*.1.85m to the N of the N floor joist). The tenon end of this post was only partially charred, because this end of the post fell beyond the main fire. Surprisingly, it was not completely destroyed by the ridge beam, which must have collapsed down leaving the post still standing and the tenon relatively intact.

The timber fragment could be identified as the end of a post on the basis of the surviving tenon, as this joint type was used only on the six posts to attach the ridge beam to the ridge-posts and the upper tie beams to the corner-posts, and also on both ends of the two door-posts. It is only the images of the fire, which showed where the ridge-post fell, that enables the upper end of the W ridge-post to be positively identified (Plate 3.2). The images show that the W ridge-post snapped below the level of the top of the pit, and fell N over the top of the N upper purlin, which straddled the length of the pit E–W. Without these images, the tenon would probably have been identified, mistakenly, as part of the NW corner-post given the close proximity of its position to the NW corner of building. The location of the E ridge-post was less clear from the images, although it appeared to have fallen SW towards the doorway.

The charred upper part of (probably) the NE corner-post, *c*.0.85m long, with part of the tenon surviving, was located on the ground surface also along the N side of the remains (Plate 3.5). The top end of this charred post fragment was located NW of, and *c*.2.85m from, the *in situ* base of the NE corner-post (*c*.1.70m to the N of the N floor joist). The charred tenon was roughly in line with, and *c*.4.30m from, the upper end of the W ridge-post (see above). The top end was also located *c*.4.30m from the base of the *in situ* E ridge-post. Without the images taken during the fire it would be quite reasonable to assume that they were both fragments of ridge-post. However, the images clearly show that the E ridge-post collapsed inwards, and apparently towards the SW, while the NE corner-post fell towards the N.

In contrast to the upper parts, the base of all six posts, as well as the central posts midway along the long sides of the cellar, survived *in situ* at varying heights in the pit. The E ridge-post was the most substantial surviving post,

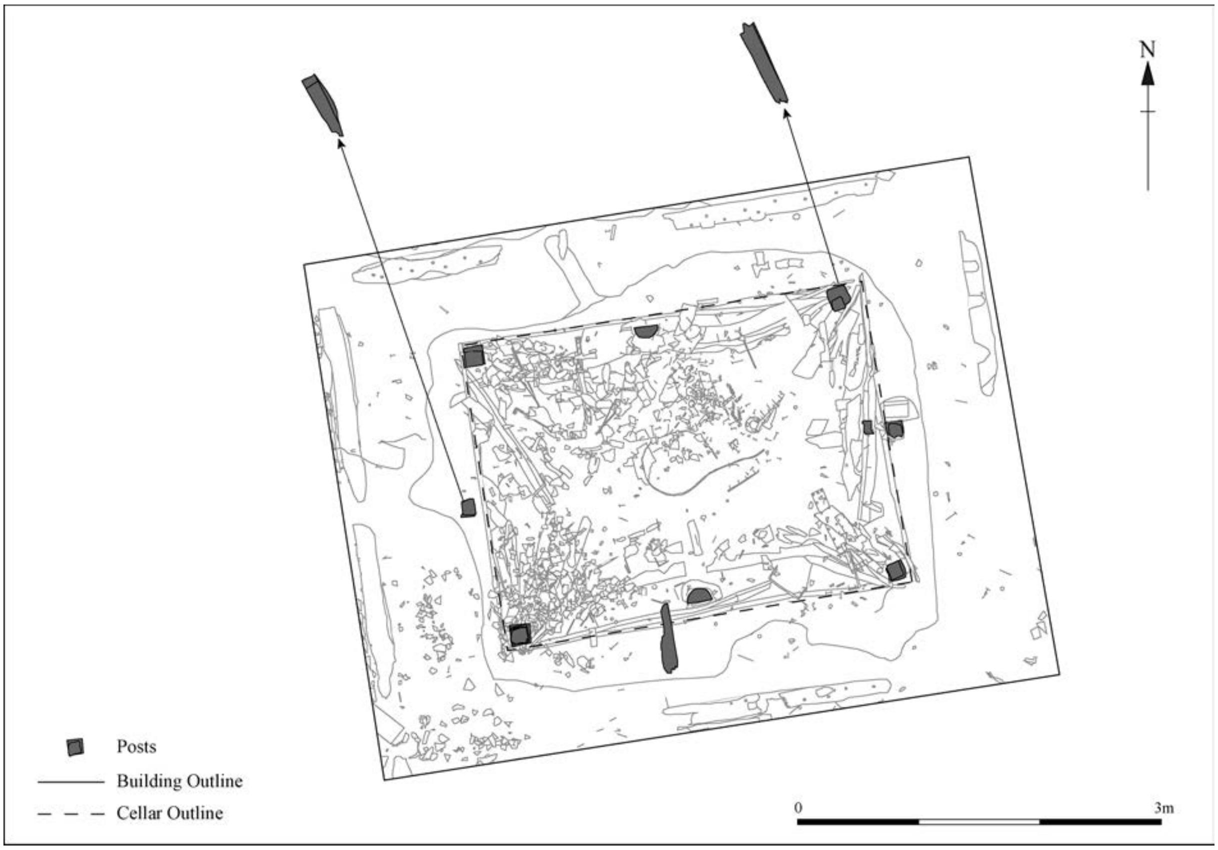


Figure 3.4 Plan of surviving structural post fragments

Plate 3.5 The tenon end of the NE corner-post, lying across the flat upper end of a wall board from the N wall

Plate 3.6 The uncharred base of the E ridge-post (top) within the post-hole (viewed from N), behind the lowest *in situ* cellar lining and the burnt sand base of the cellar; (above) after extraction from the post-hole in October 2005

1.82m long (i.e. 29% of the post surviving *in situ*). The top of the post was charred, and roughly level with the ground surface, *c*.1.30m above the base of the cellar lining (Plate 3.6a). In comparison, the top of the W ridge-post was *c*.0.55m below the level of the ground surface and only *c*.0.70m above the base of the *in situ* cellar lining.

The two N corner-posts snapped off and/or burnt down to the lowest level of all the posts, *c*.0.80m below the ground surface. In comparison, the tops of the surviving S corner-posts were slightly taller, surviving up to *c*.0.50m below the surface. Less remained of the central posts, midway along the long sides of the cellar. The charred top of the *in situ* post along the S side survived to a height of only *c*.0.25m above the base of the lining. On the opposite side of the pit, the top of the post was only *c*.0.16m in height above the base.

Only the upper, exposed part of each surviving *in situ* post was charred, while those parts that had been sealed from oxygen were uncharred, albeit in varying states of decay. Consequently, all the post bases, sealed within their post-holes, survived without any charring. Those parts of the posts protected by the accumulation of material on the base of the cellar during the use of the building were also completely uncharred. Furthermore, the lower parts of the ridge-posts, sealed and protected by the collapse of the unconsolidated sand sides of the pit after the upper part of the cellar lining gave way (prior to which they had been sealed behind the plank lining), were also completely unburnt (Plates 3.6a and b).

In addition, within the SE quadrant of the cellar pit, a short, heavily charred piece of timber, *c*.0.30m long x 0.14m thick, was recorded as part of the SE corner-post. The timber sloped downwards into the pit, SE–NW aligned from the SE corner-post, between the remains of the collapsed cellar boards from both the S and E sides of the pit.

Evidence of floor joists

Approximately half the outer floor joists survived as partially charred timbers around the outside of the pit, onto which both the floor and the wall boards had originally been pegged. However, only *c*.31% of the E (N–S) joist survived compared to *c*.75% for the opposite W joist (Fig. 3.5, Plates 3.7a and b).

Just over half (*c*.57%) the N (E–W) floor joist remained, *c*.3.60m in total of the original joist that was 6.30m long. However, the joist survived in two sections separated by *c*.1.60m. The middle section of the joist had been destroyed, probably as a result of animal burrowing underneath the joist which would have increased the ventilation, resulting in preferential burning in this area (Chapter 6). When the cellar lining collapsed into the pit, the burrow was exposed in the pit side, *c*.0.20m wide (Plate 3.8).

In comparison, on the opposite side, only one partially charred section of the S joist survived, *c*.2.25m in length (*c*.36% of the original joist), along the central E part of the building. The E end of this joist had been destroyed completely as had that part of the joist to the W of the door. There was a line of small charcoal fragments roughly the width of the original joist on the W side of the door.

The W joist survived in two main pieces and it was the most complete of the four joists. Three quarters (*c*.3.90m) of the joist survived, compared to only *c*.1.60m of the opposite E joist (*c*.31%). However, the S end of the joist had completely burnt away, and the canister from the fire extinguisher lay across the line of the joist (Plate 3.9). There was also a gap of *c*.0.20m between the two parts of the joist, where the central (E–W) joist had completely burnt away (see below). A chain was draped over the joist, which had been stored originally on the platform above. On the E side of the building, only one heavily charred piece of the joist remained towards the N end, *c*.1.60m long.

The central floor joist, which straddled the cellar pit E–W, had been completely destroyed during the fire. The intersection with the two N–S joists, onto which it had

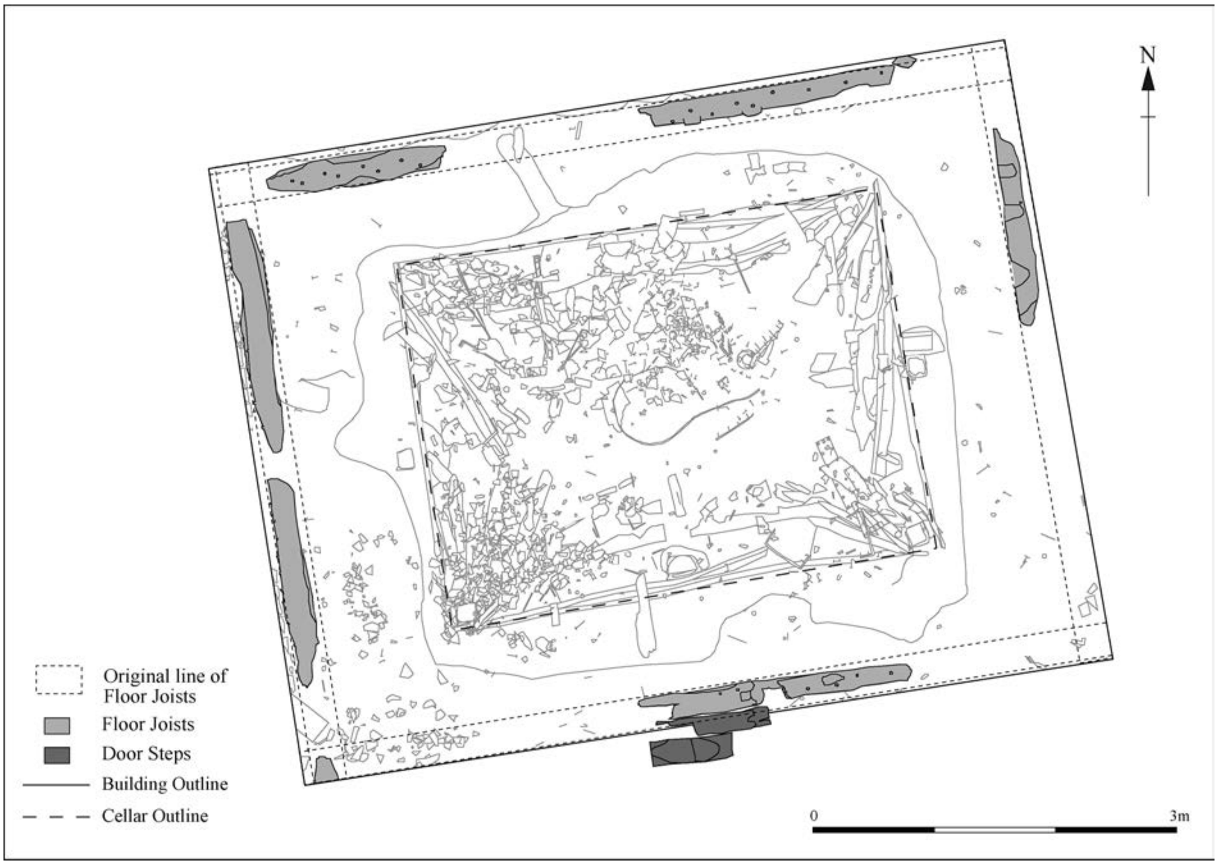


Figure 3.5 Plan of the surviving floor joists and doorsteps

been half-lapped, was marked by gaps where the joint had completely burnt away. In fact, all the joints had been completely destroyed. All four corners had been destroyed where the outer joists had been half-lapped together, although the SE, in particular, and the SW corners were more severely affected than the N corners of the building. The S end of the W floor joist possibly survived as a charred fragment, *c*.0.30m long, in line with this joist. Where the joists had been completely destroyed, the ground surface was burned bright orange to a depth of *c*.0.04m below the surface and marked their original location (Plates 3.10 and 3.11).

The surviving joists appeared to be heavily charred but in general, like many of the surviving timbers, the charring was superficial and formed only a thin outer layer. The underside of the surviving joists was uncharred and the ground surface below the surviving joists was completely unburnt (Plate 3.12), except in those areas around the outside of the building where erosion had occurred and the joists had been undercut. Similarly, the area behind (on the N side of) the S floor joist had been protected by the accumulation of soil below the floor planks inside the door, producing a distinctive char pattern (see below).

There were no remains of any floor planks surviving *in situ*, attached to the floor joists. There were no surviving wall boards, although the bases of a number of wall boards were found *in situ* (see below). The charred pegs that had held the planks in place were, however, clearly visible

Plate 3.7 The outer floor joists a) before (viewed from E) and b) after removal of surface remains, showing the burnt orange sand below, and marking, the position of the floor joists (viewed from W)

Plate 3.8 The remains of the N floor joist, and the destruction caused by the animal burrow below the central part of the joist (viewed from N)

Plate 3.9 The fire extinguisher lying across the wall-line on the W side of the building (viewed from S). Pot-sherds from the vessels stored on the shelf at the W end of the building are strewn across the ground surface within the internal area of the building and across the line of the (destroyed) S floor joist. The pale sherds in the foreground are from Vessel 1 (V1), while the red- brown sherds in the background (to the N) are from V2 and V5

Plate 3.10 The burnt orange sand marking the line of the S floor joist, which had been completely destroyed, after removal of the surface remains (viewed from W)

where they had snapped off level with the surface of the joists. In several places, particularly on the upper face of the N floor joist and also on the S joist, there were areas that had only been lightly scorched. These areas appeared to have been protected from heat damage, presumably by the survival of the floor planks until a late stage in the sequence.

Evidence of the walls

In comparison to the frame, there was considerably more evidence of the walls, consisting of the remains of 45 wall boards (max.) that fell outwards and away from the building (Fig. 3.6 and Plate 3.3). Of this total, the remains of 25 wall boards survived on the W side of the building, 14 on the E side and only six, in total, along the N and S sides of the building.

Plate 3.11 Section across the burnt ground surface where the N floor joist had been completely destroyed along the N side of the building (viewed from W). The ground was burned bright orange to a depth of *c*.0.04m below the surface

Plate 3.12 The W end of the building after the removal of the surviving floor joists, showing the unburnt areas directly below (viewed from S)

No wall boards were defined within the internal area of the building, although the images of the fire show that at least some fell inwards, and boards can be seen lying across the fallen wall-plate on the N side of the building (Plate 3.1). These boards had either been completely destroyed during the fire or reduced to small and unidentifiable charred fragments, of which there were many within the pit.

The images of the fire show that most of the wall boards burned through, and snapped off, immediately above the floor joists, onto which they had been pegged. They also show that (at least) several of the wall boards remained vertical, pegged in place to the floor joist, after the wall-plates had collapsed. The pegs attaching the top of the wall boards to the wall-plate had either burned through or snapped off with the weight of the collapsing wall-plate.

The bases of fewer than 20 boards survived *in situ*, i.e. still vertical against the floor joist, of these, the bases of 14 boards were located along the W side of the building (Plate 3.13). All of these boards had burnt down below the level of the pegs and were less than *c*. 0.10m high (max.). The bases of three wall boards survived along the S (W) side, although the floor joist was completely destroyed along this part of the building. This section of the joist was present in the photographs taken the following morning, and smouldered away after the main fire. The position of several other boards was clearly indicated by burnt sand

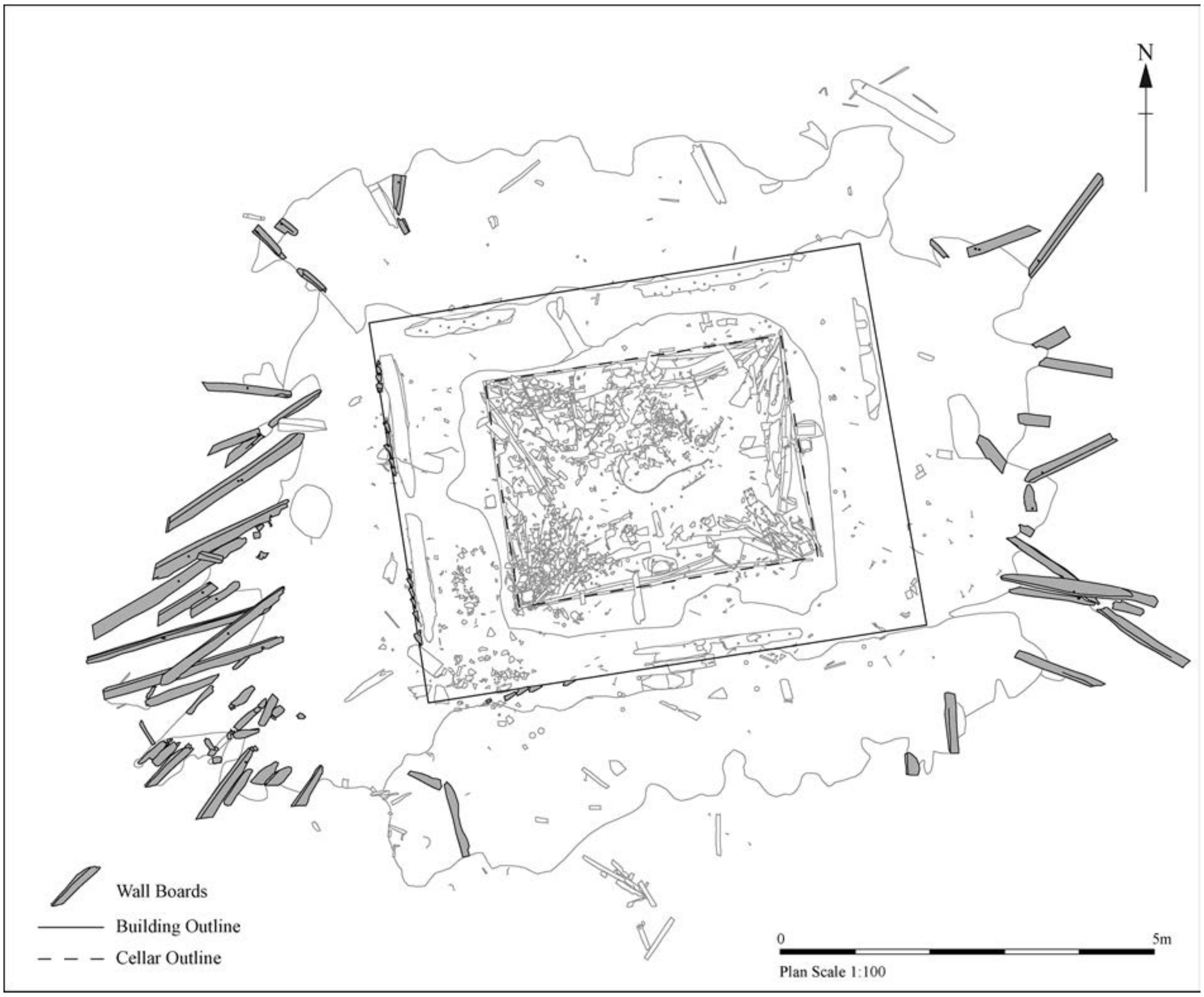


Figure 3.6 Plan of surviving wall boards that fell outwards onto the ground surface, outside the building footprint

marks. In addition, slight hollows on the outer side of the surviving joists, along with the charred pegs, indicate the original position of the wall boards, where the slight gap between the boards and the floor joists had caused preferential burning along the outer side of the joists.

The remains of the wall boards on the W side of the building demonstrate that a large part of the W gable-end wall fell outwards. There were the remains of 24 or 25 boards along the W side with a combined length of *c*.28.30m, which is estimated at *c*.25% of the original wall. The longest surviving board from the W wall measured *c*.2.55m, although six were over 2.00m long and nine over 1.00m long. In general, the surviving boards from the N half of the W wall were longer and generally more intact; all six over 2.00m were from the N or central parts of this wall.

With the exception of several that lay E–W, the boards from the W wall were NE–SW aligned and had fallen to the SW. The boards were lying parallel in a group and the uniformity of their alignment suggests they had collapsed *en masse* (Plate 3.14). Linear patches of burnt sand and also linear patches or lines of charcoal fragments defined the position of the lower end of these boards, closest to the building, which burnt away on the ground. In general, the parts of wall boards closest to the building, in the area *c*.1.00–2.00m from the wall-line, had been completely destroyed. This was the case around all sides of the building. With the exception of several small charred fragments, all timber that fell in this zone was completely destroyed (Chapter 6).

Less survived of the E gable-end wall and there were the remains of only 13 or 14 partially charred wall boards, although the images of the fire show that many of the E wall boards also fell outwards onto the ground surface (Plate 3.15). These had a total combined length of *c*.15.25m, which is estimated at *c*.13% of the original wall. The remains of eight boards were over 1.00m in length, and the longest single surviving board measured *c*.2.15m, although

Plate 3.13 The heavily charred base of five wall boards *in situ* along the W side of the building (viewed from W)

Plate 3.14 The group of wall boards from the W wall that had fallen to the SW, probably collapsing *en masse* (viewed from SW). The fire extinguisher, lying across the line of the W floor joist, is visible in the background

Plate 3.15 The surviving wall boards from the E end of the building (viewed from S)

Plate 3.16 Underside (outer facing side when attached to the wall) and top (cut) edge of one of the surviving boards from the W wall. The main face of the board and the protruding end of a peg, which fixed the plank to the outer upper tie beam, are unburnt and the tool marks are clear

Plate 3.17 Several wall boards buried in a pit (one of four in total) in December 2005, in order to monitor the rate of decay. The boards were sectioned before burial, showing that the char depth was shallow; only the surface and ends of the surviving timbers was charred

two fragments from a single board burnt through in the middle by another board had a combined length of *c*.2.95m.

In general, there was less uniformity in the alignment of the surviving boards on the E side. Some boards had fallen straight out and were E–W aligned but one, in the NE corner, was NE–SW aligned and several in the SE corner were SE–NW aligned. One board lay outer side up so it must have twisted over as it collapsed or possibly bounced over after hitting the ground, because the uncharred outer face was uppermost. Similarly, a board from the NW end of the wall was facing the wrong way up. The location where individual boards had burnt away on the ground at the E end of the building was also marked by linear areas of burnt (orange) sand and also, in some cases, linear areas and lines of charcoal fragments. Several boards could be traced for a further *c*.0.70–1.00m based on the pattern of burnt ground.

The top (cut) edge of many wall boards, at both ends of the building, survived remarkably well and with only slight charring, presumably because they fell furthest away from the fire at a relatively early stage (Plate 3.16). The top end of several boards had fallen over 4.00m away from the original wall-line on the W side of the building with the furthest *c*.4.30m from the wall-line. On the E side, the upper end of boards had fallen up to *c*.3.50m from the original wall-line. Similarly, the under sides (outer faces) of many surviving boards were only slightly charred and survived relatively intact with evidence of the rebate along one edge.

Consequently, it has proved possible to determine the original position of many boards; for example, at the W end three of the central boards were distinguished, with flat top ends cut for the smoke holes. Eight surviving wall boards from the W gable-end and two from the E wall were sectioned prior to burial, to examine char depth, as part of the timber experiment (Plate 3.17). In all cases only the very outer surface of these boards was actually charred.

In comparison to the gable ends, very little survived of the N and S long walls. In total, less than 3% of the wall boards from the N and S sides survived the fire. There were charred fragments of only six wall boards along these sides, all of which were located close to the corners of the building. However, like the surviving boards along the gable-ends, the top (cut) end of these boards also survived relatively intact, up to *c*.2.10m from the original wall-line. All the other boards that made up these two walls had been completely destroyed. As previously stated, little was preserved close to, and up to *c*.1.00–2.00m from, the original wall-line. The wall boards from these walls were only originally 2.00m long and, consequently, these boards would have been destroyed had they fallen outwards onto the ground surface.

In the images of the fire, a number of wall boards (and/or possibly rafters) along the N side are shown lying across the piles of burning thatch on the ground, and clearly fell outwards, but there was no surviving evidence of them. There was, however, a number of linear voids in the thatch-ash piles which survived for a short time after the fire but they had been completely destroyed by the time of the excavation. These voids appeared to mark the position of collapsed timbers that had entirely burned away and through the thatch ash.

There were the remains of three boards along the N side, all of which were located towards the NW corner of the building and two of them were aligned NW–SE. These three boards had a combined length of *c*.2.00m, which is *c*.2% of the original wall. The longest of these boards survived in two pieces, burnt through in the middle, and *c*.1.25m long in total. The top (cut) end of all three survived intact, up to *c*.2.00m from the wall-line.

There were also the remains of three boards from the S wall. These had a combined length of *c*.2.60m, which is estimated at *c*.4% of the original wall. The longest board, in the SW corner, had broken in two pieces and had a total length of *c*.1.45m. The top (outer) end of this board was located *c*.2.10m from the wall-line.

Evidence of the window

Fragments of slats from the window shutter were spread across an area between *c*.1.30–3.90m S of the wall-line and the position of the window, and spread *c*.2.40m wide E–W (Fig. 3.7). There was otherwise no way of defining either the presence or position of a window.

The main concentration was located between *c*.2.50–3.90m S of the erosion hollow in front of the entrance, and beyond the heap of thatch ash (see below). One slat was complete and uncharred, while several others were almost complete and/or only partially charred but there were other short fragments with charred edges. Four shutter fragments all heavily charred lay closer to the building, within the area of the thatch ash.

The window had been shut and, assuming the shutter had not been broken and pulled out when the building was broken into, the shutter slats must have been thrown out with some considerable force. They were perhaps catapulted out as falling timber from the superstructure, such as the wall-plate, collapsed down and smashed the frame (Chapter 6).

Plate 3.18 The morning after with the remains still smouldering, showing the remains of a substantial squared timber, probably a door-post, sloping down the S side of the pit (viewed from NW). Notice the prominent sand ridges on the ground surface beyond the S side of the pit, which had accumulated below the suspended floor on the surface in the area immediately inside the doorway

Figure 3.7 Plan of surviving window-shutter fragments

Evidence of the entrance
There was no evidence of the door itself, which had already been destroyed by the final, recorded stages of the fire. However, the door-posts were two of the last parts of the superstructure to collapse. The images of the fire show that the door-posts fell after the ridge-posts and they were still upright when recording of the fire ceased at 04.37hrs (Plates 3.1 and 3.2).

Plate 3.19 The charred doorsteps and (behind) the S floor joist with the remains of the mortise for the tenon end of the E door-post still apparent (viewed from S)

There was a partially charred fragment of (squared) structural timber, *c*.0.65m long, sloping down the collapsed S side of the cellar pit, which is probably the remains of the W door-post (or possibly the E ridge-post which fell SW towards the doorway). This fragment must have fallen towards the N and into the pit at a relatively late stage in the sequence after the cellar lining had collapsed inwards. The images taken the following morning show a much longer fragment, resting against the upper edge of the cellar pit (Plate 3.18). Therefore, it continued to smoulder and it also collapsed further down into the pit, presumably as a result of erosion to the side. It was recorded *c*.0.35m N of the S floor joist and in line with the location of the W door-post.

In addition, the images taken the morning after show a further, shorter fragment of structural timber sloping further down the pit side, *c*.0.30m to the W, which could also have been part of a door-post or another post, or possibly part of the S wall-plate. This fragment burnt away completely and no evidence of it was recorded during excavation.

The charred remains of the mortise that held the tenon-end of the E door-post was still apparent on the S outer floor joist. The mortise for the W door-post had burnt away leaving a large gap in the joist, but still marking the position of the mortise. There were also the partially charred remains of the two doorsteps, and the remains of

Plate 3.20 The char pattern on the inner (N) face of the S floor joist, showing the location of two ridges of material (marked as uncharred areas) that accumulated below the suspended floor directly below the doorway (taken after excavation in January 2006). The less prominent ridge on the left side was directly below the mortise for the E door-post

Plate 3.21 A pile of thatch ash along the N side of the building remains immediately after the fire (viewed from W). Notice that the material around the outer edge of the thatch deposit is uncharred. The upper tenon end of the W ridge-post is lying across the thatch

the external post that wedged the door open, immediately to the E of the door, and also several stakes, burnt down to ground level (Plate 3.19).

In addition to the charred remains, prominent parallel ridges of fine unconsolidated sand had accumulated below the gaps between floor planks, at ground level, immediately inside the doorway (less so elsewhere around the sides) and these were clearly defined against the remains of the S floor joist (see below; Plate 3.18). The ridges had completely disappeared by the time of the excavation and were defined as a discrete surface layer on the edge of the pit. The original extent of the ridges (and troughs) was also clearly defined by the burn pattern on the inner (N) face of the floor joist (Plate 3.20).

In contrast to the accumulation of material inside the doorway, a substantial hollow extending *c*.5.00m S from the building and *c*.7.00m E–W, *c*.0.20m in depth, had formed immediately outside the entrance and also below the position of the window (Plate 1.5). The base of the hollow was marked by a compacted gravel surface. This was not a laid or prepared surface; it was caused by trampling and compaction, and by the removal of the unconsolidated sand, whether on shoe soles and/or by wind erosion.

Evidence of the roof

No timber remains of the roof, such as rafters or batons, were positively identified within the internal area of the building, either within or around the edge of the pit, although clearly much of it must have collapsed down into the pit. The evidence for roofing materials, both on the surface and within the pit, indicated from the analysis of the plant remains, is discussed by Gill Campbell in Chapter 5.

There was, however, the remains of a small number of roofing materials on the ground surface around the outside of the building, in the form of ash deposits from burnt thatching straw and also several areas of unburnt straw, as well as fragments of several charred, partially charred and also uncharred rafters and fixings (Fig. 3.8). These were, in general, located on the outer edge of the burnt area, and farthest from the fire, particularly around the corners of the building.

Plate 3.22 The remains of thatch ash along the N side of the building before excavation (viewed from W). The heap that was visible immediately after the excavation has been reduced to a thin and discontinuous layer

The images of the fire show two large heaps of burning thatching straw, on the ground along the long sides of the building, demonstrating that at least the lower part of the thatch simply slid down and off the sides of the roof (Plates 3.1 and 3.2). This resulted in two prominent heaps of thatch ash, *c*.0.25m high (max.) along the S and N sides of the building, extending up to *c*.2.00m from the wall-lines, although the main extent of the (surviving) thatch was only *c*.1.00m from the outer joist. The thatch around

Plate 3.23 An excavated segment across the thatch ash along the N side of the building, which shows both the shallowness of the surviving thatch, originally a mound, and also the lack of burning to the ground surface directly below. Plant recolonisation has already begun, particularly along the edge of the deposit

Plate 3.24 Preserved thatch directly below the remains of a wall board from the S long wall, in the SW corner of the building

Plate 3.25 Surviving uncharred roof fixings, principally hazel batons and tarred twine, around the edge of the charred thatch ash deposits along the S side of the building remains (viewed from SW)

the outer edges of these heaps furthest from the fire, particularly around the NE corner of the building, was only partially charred (Plates 3.18 and 3.21). There were also the remains of smaller thatch ash piles along the gable ends, *c*.0.70–0.80m x 0.40–0.50m in area, where the ridge thatch had dropped down from the eaves. Both were located *c*.0.75–0.80m from the wall-line.

By July, four months after the fire, the heaps of charred thatch had been reduced to thin layers of ash *c*.0.03–0.04m deep, as a result of erosion and weathering (Plate 3.22). In some places, the ash had almost completely disappeared and there were areas of bare soil. In contrast to the areas of bright orange burnt sand below the timbers that burnt on the ground surface, the soil below the thatch ash had not been burnt or discoloured (Plate 3.23). The surface vegetation had been destroyed by the burning thatching straw but in several places, particularly around the edges, plant regeneration and recolonisation had occurred by the time of excavation. Some animal (principally mole and rabbit) disturbance occurred in the two weeks preceding the excavations, with a substantial rabbit burrow on the S (E) side (Plate 3.4). The charred thatch was well-preserved where it had been protected directly below remains of the wall boards lying along the N and S long sides of the building, which fell outwards on top of the burning piles of thatch (Plate 3.24; Chapters 5 and 6).

There were only three identifiable fragments (*c.*1.10m in total) of charred or partially charred rafter, which is estimated at *c*.1% of the original total. The longest fragment, *c*.0.75m long, was aligned NE–SW on the surface beyond the SW corner of the building, *c*.0.45m outside the line of the (destroyed) W floor joist. There was a short length, *c*.0.20m long, on the (N) W side of the remains and *c*.0.35m W of the W floor joist. There was also the lower (cut) end of a charred rafter, *c*.0.15m long, along the N (W) side, *c*.1.10m to the N of the N floor joist.

A small number of roof fixings were recovered from the remains along with several piles of unburnt thatch. All were located around the edges of the burnt area in the SW, NW and NE corners of the remains, up to *c*. 2.00m from the wall-line (Plate 3.25). These consisted of a small number of un- and/or partially charred fragments of hazel batons, one split and twisted hazel spar, several split hazel liggers and several lengths of tarred twine. They survived presumably because they were on the edge, and/or had been thrown clear, of the fire, which was driven SE by the wind.

The longest baton fragment, *c*.0.70m long, was located on the N side of the remains, *c*.1.55m from the N floor joist. A small part of this baton, *c*.0.04m long, was only scorched where the tarred twine had been wrapped round the baton. There was a further short fragment of charred baton located to the E of the first and *c*.1.00m from the floor joist. There was a short fragment of baton on the line of the same joist but this appears to have been thrown in later by visitors, along with several other uncharred hazel fragments, because it does not appear on the images taken from the crane (Plate 3.3).

However, in the SW corner and on the very W edge of the charred thatch deposit, *c*.1.00–2.30m from the building, there was a small group of baton fragments, up to 0.28m long, and also several short lengths of twine (Plate 3.25). One piece of twine was still twisted around a short

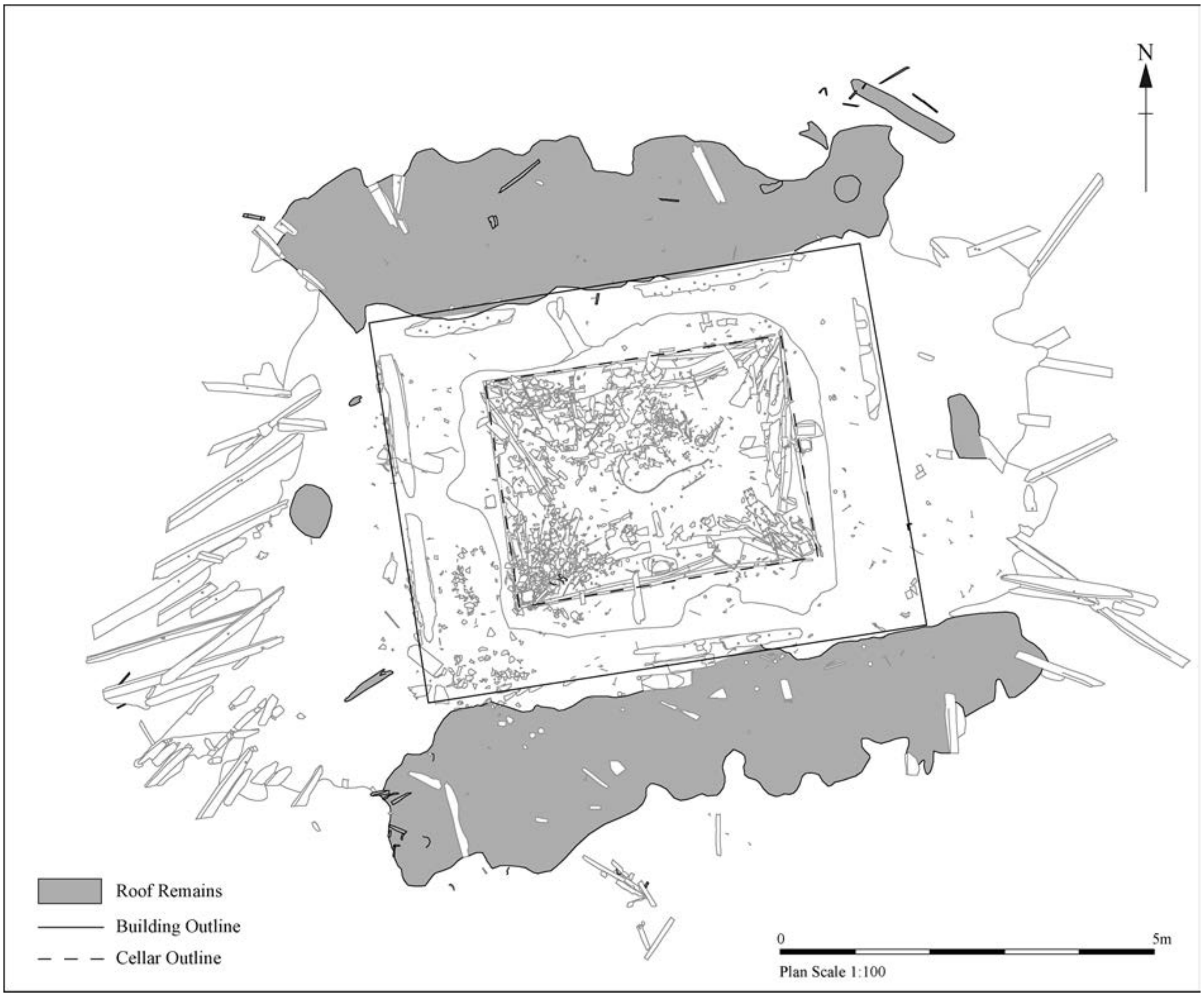


Figure 3.8 Plan of surviving roof remains. Like the limit of the burnt ground, the extent of the thatch ash deposits is indicative because there was no definite boundary

fragment of baton. In the NW corner there was a single piece of baton, *c*.0.30m long, located *c*.2.05m from the projected corner of the building, close to a pile of uncharred thatching straw. There were several similar piles of uncharred thatch around the NE corner of the remains, of which the most substantial patch measured *c*.1.55m x 0.20m in extent. These were located up to *c*.2.00m from the corner of the original building, marking the edge of burning around this corner. There were several split hazel ligger fragments, used to hold the ridge capping and fixed in place with split hazel spars, up to *c*.2.40m from the corner of the building. The longest fragment measured *c*.0.40m long**.** There was also the twisted end of a hazel spar, *c*.2.10m from the wall-line.

Evidence of the suspended floor

The remains of nine (max.) heavily charred floor planks were defined within the pit, less than 5% of the original floor (Fig. 3.9 and Plate 3.26). The longest surviving plank was *c*.1.65m in length. These had fallen *c*.1.40m from their original position suspended over the cellar on the floor joists. No floor planks were defined on the ground surface, around the edge of the pit.

The most substantial remains were defined in the E/NE and SW parts of the pit, with further possible floor plank fragments in the NW part. In all cases, they were lying roughly horizontal and at the same level, and several on the same (roughly N–S) alignment, on the base of the cellar, although they were *c*.0.20m above the undisturbed natural cut of the cellar pit. The surviving floor planks on the base were sealed below the remains of the cellar lining, which demonstrates that they had fallen before the lining collapsed in, although not all the floor planks necessarily fell at the same time (see below). The floor planks on the base of the cellar were entirely carbonised, unlike many of the surface remains that were only superficially charred; it seems likely the earth that collapsed down into the pit from behind the cellar lining limited the oxygen level and thus resulted in their carbonisation rather than total destruction.

In the E part of the pit (NE quadrant), the remains of at least two charred floor planks were defined, embedded within, and/or surrounded by, a layer of burnt sand, ash and charcoal, and above a dark yellow burnt sand layer, which was interpreted as the base of the cellar at the time of the fire. The longest plank fragment was aligned roughly N–S against the lowest *in situ* cellar lining on the (N) E side of the pit. The plank lay in two pieces, separated by 0.10m, and measured *c*.1.65m long (in total) x 0.18m wide x 0.06m thick. Only the central part of the floor plank survived and the cut-ends, which had been pegged onto the floor joists, had completely burnt away. The N end of the surviving plank fragment was located *c*.0.30m S of the

Figure 3.9 Plan of surviving floor planks on the base of the cellar

in situ NE corner-post and the S end was *c*.0.80m N of the SE corner-post. However, there was no evidence of the central E–W joist, onto which this plank had also been pegged, although it is possible that the gap between the two fragments marked the location of this joist.

A second charred floor plank was aligned NE–SW to the W of first, in the NE part of the pit. The surviving plank was considerably shorter, however, and measured *c*.0.75m long x 0.20m wide. A further possible collapsed floor plank fragment was also defined in the NE part of the pit, at the same level as the other two floor planks. It was aligned roughly NNE–SSW and measured 0.16m long (min.) x 0.14m wide.

Plate 3.26 The two charred floor planks on the base of the cellar in the NE quadrant, with the lowest *in situ* cellar lining and charred base of the NE corner-post (viewed from W). The cauldron chain is visible in the centre of the pit

In the SW part of the pit, the longest surviving charred floor plank measured 1.15m long (in total), with a gap of *c*.0.10m in the middle where it had broken into two separate pieces on impact, x 0.14m wide (max.). The charred plank was aligned SW–NE, to the E of the SW corner-post and parallel to (and at a similar level to) the remains of the collapsed cellar lining, *c*.0.20m to the W; the stratigraphic relationship between the two was not established. The charred floor plank was located immediately below a group of objects that included large and conjoining pot-sherds of Vessels 1 and 2, which were originally on the platform above the lower tie beam at the W end of the building (see below). It would appear that these vessels collapsed down on to the suspended floor, because the images taken during the fire suggest the suspended floor was still in place after the superstructure had collapsed. Therefore, the remains of these vessels subsequently collapsed down into the base of the cellar when the floor gave way, at which point presumably the large pot-sherds were further broken.

A second possible floor plank was defined *c*.0.30m to the W, at a slightly lower level in the SW part of the pit. The charred remains of this plank measured *c*.0.55m long x 0.14m wide. There were also several shorter lengths, each *c*. 0.20m long, that might also have been fragments of collapsed floor planks.

The charred remains of several possible floor planks were also defined in the NW part of the pit. One was aligned NW–SE in front of the NW corner-post and traced for *c*.0.35m (in two separate pieces) x 0.17m wide, but this could be a fragment of board from the cellar lining. The second was lying roughly N–S at a slightly higher level and towards the centre of the pit. It was *c*.0.50m long x 0.24m wide.

The stratigraphic evidence within the pit demonstrates that the surviving floor planks had fallen before the lining gave way because the lining was above the remains of the suspended floor. This enables a sequence of destruction to be put forward because the images of the fire show that at least part of the suspended floor was still in place after the superstructure had been destroyed. The images of the fire show the N purlin resting across the fire-box, which was still relatively intact and supported on the suspended floor[iii], after the main superstructure (with the exception of the posts) had already collapsed (Plates 3.1 and 3.2). At least, the central section of suspended floor, and by implication also the central supporting joist, had yet to collapse down into the pit. Clearly, these floor planks still had considerable integrity at a relatively late stage in the fire, at least after the entire superstructure had collapsed, given the weight they were still supporting; the purlin alone weighed a third of a tonne. Moreover, they were also strong enough to absorb the impact of the collapsing timbers.

The same images indicate, however, that some of the floor planks were missing — presumably broken as parts of the superstructure fell onto them — and show flames leaping up from within the pit. Therefore, the floor planks from the suspended floor collapsed differentially rather than in a single and cataclysmic event. The area around the cellar trapdoor would have been subject to preferential burning because of the greater degree of ventilation to this area (Chapter 6). The joints were also weak points, because the planks were thinner while the surface area was larger and ventilation higher. They would also have been subject to preferential burning, and therefore structural collapse. Similarly, gaps between floor planks (which there certainly were; see below) would have exacerbated the rate of destruction to the adjacent planks. Presumably, once the supporting central E–W joist gave way and collapsed, any remaining suspended planks would also have been pulled down into the base of the cellar.

Evidence of the lined cellar

The remains of the cellar consisted of an irregular sub-rectangular pit, which measured *c*.4.80m E–W and *c*.3.85m N–S (max.). In plan, the pit was *c*.1.00m longer and wider than the original size of the lined cellar, which measured 4.00 x 3.00m: at ground level, the pit measured 17.40m^2 after excavation[iv] compared to the original lined cellar that measured 12.00m^2 (Figs 3.2–3.3 and 3.10). However, a certain amount of the erosion and side collapse had taken place in the months after the fire. Also, the unconsolidated sand sides collapsed on several occasions during excavation, further enlarging the overall size of the pit.

On each side, the top of the pit had collapsed back *c*.0.55m (max.) behind the position of the original cellar lining by the time of excavation. There was a gap of only *c*.0.25m between the top of the pit and the remains of the floor joist along the S side of the building; this joist had originally been located *c*.0.80m from the side of the lined pit[v].

With the exception of the lowest board, which was still *in situ* around all four sides, the cellar lining had been forced inwards and down into the pit by the pressure of soil from behind it. Along the N and S long sides of the pit, the boards were in multiple pieces. The board ends were still vertical, wedged behind the remains of the corner-posts and still stacked above the lower *in situ* boards. The middle section of each board had collapsed forwards and down; some were lying horizontally, aligned parallel to the side of the pit, over material that had already fallen from the superstructure. The charred remains of several floor planks were sealed below the collapsed lining. Therefore, the lining collapsed after at least some of the floor planks had fallen into the base of the pit. The N and S long sides probably collapsed into the pit when the central N–S joist and the central posts along the long sides gave way. The remains of a squared timber, 0.39m long x 0.12m wide, possibly a fragment of the central joist, were defined tipping down the collapsed material on the N side, aligned N–S and roughly in line with the central posts.

When the cellar lining gave way, the unburnt sand behind it — the packing layer in the cavity behind the lining and the battered sides — collapsed down into the base of the pit. This slumped deposit was *c*.1.00m deep (max.) above the base of the lining around the sides, sloping gradually at an angle of between 20–30 degrees, down into the base and extending *c*.1.60m (max.) into the centre of the pit (Plate 3.27). This material, which was mainly unburnt, sealed both the remains of several collapsed floor planks and the collapsed cellar lining, and presumably suffocated the fire below it.

The upper sides of the pit, exposed following the collapse of the lining, were reddened and burnt to a depth of several centimetres, which indicates the fire continued to burn for some time after the upper (lined) cellar sides collapsed down into the base of the pit, presumably fuelled by timber from above. By the time of the excavation, much of the burnt sand had collapsed down into the base leaving the upper sides unburnt as a result of erosion to the unconsolidated sides during the intervening months. The burnt sand formed a thin layer above the collapsed sides sloping down into the base of the pit, along with other material eroded from the surface around the sides of the pit, which included sherds from a broken vessel around the SW corner of the pit and many unidentifiable charcoal fragments. Animal burrowing had disturbed the remains in the pit, particularly against the N side and at the top of the side collapse.

Around all four sides, there was no definitive evidence of the highest board within the pit. This had been completely destroyed and/or the surviving charred fragments were too small to be positively identified.

There was some evidence of the second highest (i.e. third lowest) board within the pit. Along the E side (in the NE quadrant), a fragmentary and heavily charred piece of timber, *c*.0.50m long, was aligned NE–SW from the NE corner. It sloped steeply downwards towards the base of the pit and was overlying the second lowest board. On the N side of the pit (in the NW quadrant), a heavily charred piece of board, *c*.0.40m long x 0.30m wide, sloped down into the pit, aligned NW–SE. It also overlay the remains of the second lowest board.

On the S side of the pit, the remains of a near complete board were defined (but in several pieces), which is probably the second highest board. The W end of the

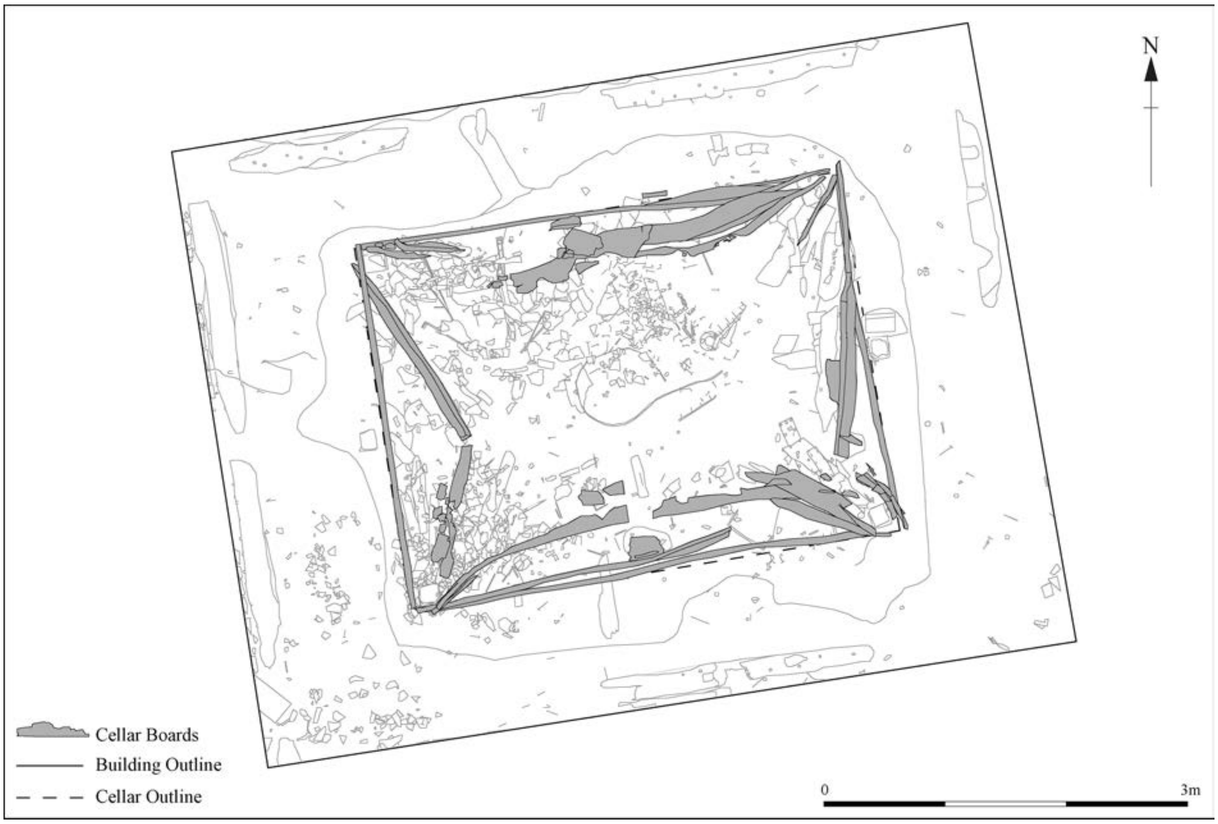


Figure 3.10 Plan of surviving and identifiable cellar remains, showing *in situ* lower boards around all four sides of the base and other collapsed boards which fell or were forced inwards and downwards into the pit

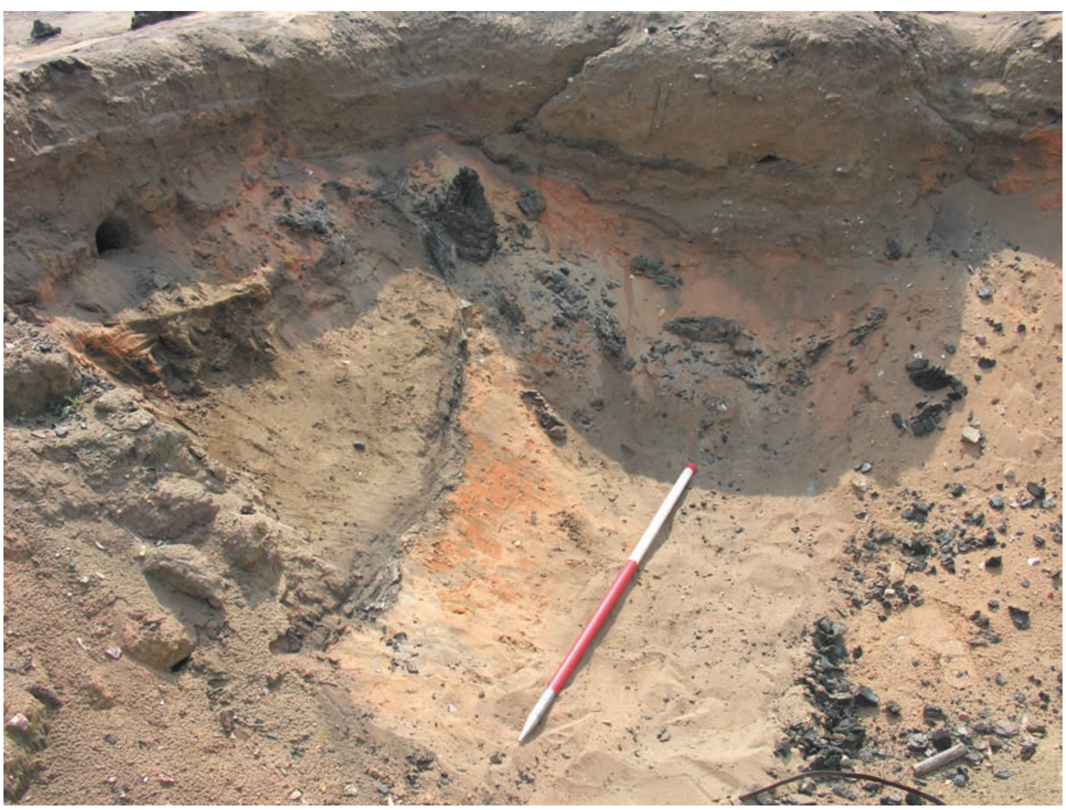


Plate 3.27 The collapsed upper cellar lining within the SW quadrant, with the charred edge of a plank curving from behind the SW corner-post down into the centre (viewed from NE). The charred board marks a clear division between burnt orange sand on the base of the cellar and brown, unburnt sand that has collapsed down from behind the lining

Plate 3.28 The collapsed cellar lining within the SW quadrant (viewed from S). The top of the lowest, and *in situ*, board is below the fragmentary remains of a board that has been forced inwards and downwards, although the W end is still vertical against the SW corner-post

Plate 3.30 The collapsed cellar lining within the NE quadrant (viewed from N). The cellar boards have been forced inwards through the pressure of soil from behind the lining, although both boards from the N and E sides are still resting vertically against the NE corner-post. The top of the lowest and *in situ* boards along both the N and E sides are also visible. Notice how the outer facing sides of the boards are uncharred

Plate 3.29 The collapsed cellar lining within the SE quadrant, wrapped around the surviving lower part of the SE corner-post (viewed from W). The remains of the E ridge-post is on the left edge of the photograph

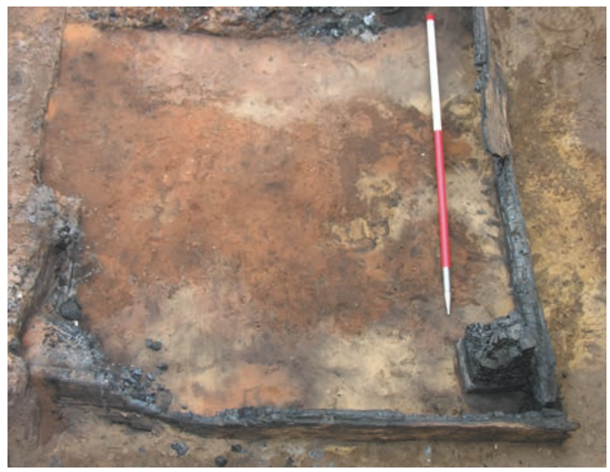


Plate 3.31 The *in situ* cellar lining within the SW quadrant and the charred base of the SW corner-post (viewed from W). The outer face of the board along the S side is entirely uncharred. The sand base is reddened but this is not uniform. Some areas of the base, especially closest to the lining, are unburnt yellow sand, perhaps due to greater accumulation against the boards

board (in the SW quadrant) was near vertical, resting against the SW corner-post. The board sloped down from beside the corner-post towards the centre of the pit, SW–NE aligned, before curving E (Plate 3.28). The central and main part of the board was roughly parallel to, but *c*.0.45m (max.) to the N of, the *in situ* lining. It was lying flat, inner face down, *c*.0.20m above the cellar floor, and had been forced forwards and down into the pit through the weight of soil behind. The E part of the board was also clearly defined in the SE quadrant, aligned E–W but curving ESE towards the SE corner-post (Plate 3.29). The remains of the board were heavily charred on the inner and under side and in multiple pieces; however, the upper and outer side was only scorched, which indicates that the board was effectively smothered after collapsing down into the base of the pit. A small section of the same board, *c*.0.30m long, was wedged behind (and over the top, charred end of) the central post on the S side of the cellar. The board had simply snapped on both sides of the post. The upper face (originally the outer-facing side of this board) was also unburnt and sealed by the slumped unburnt sand deposit from behind the lining.

In the SE corner, this board overlay a short surviving section of another board, *c*.1.20m long and aligned SE–NW, which is probably the remains of the second lowest board as it was wedged above the lowest *in situ* board. The arrangement of remains is very similar in the SW corner. A short section of board, 0.60m long and aligned WSW–ENE, was defined directly above the lowest *in situ* board. It would appear that both boards fell inwards. The second highest board fell across the top of the second lowest board, which had been almost entirely destroyed. Therefore, on the S side of the cellar only the end parts of the second lowest board survived (*c*.1.80m in total), compared to the majority of the board which survived above it. This seems to be the reverse of the evidence from the N side of the pit, where the majority of the second lowest board survived and very little evidence of the second highest board survived.

In general, there was more evidence for the second lowest board around the other three sides of the pit. This board had been forced forwards and downwards into the pit, breaking into two or more pieces. On the W side, the board had simply snapped in the middle. The S half of the board was *c*.1.15m long, aligned SW–NE from the SW corner-post. The N half, *c*.1.70m long, was aligned NW–SE from the NW corner-post. This board sloped down and inwards into the pit; the snapped S end was immediately above the cellar floor level while the N end remained near vertical and was still wedged behind the surviving lower part of the post. The snapped end of the board was *c*.0.70m from the W ridge-post, against which it was originally positioned. Both pieces were both completely charred.

On the E side of the cellar, the evidence was also quite clear. The N part of the second lowest board was still vertical, 0.65m long, and resting against the NE corner-post but NE–SW aligned. The board lay above the level of the collapsed floor planks but on an almost identical alignment. Like the board on the opposite side of the pit, it had been forced inwards; the broken (inward) end was *c*.0.40m from the E ridge-post. In the SE part of the pit, the same board was heavily charred and very fragmentary, *c*.1.40m long in total. The S end, *c*.0.50m long, was still wedged behind the SE corner-post and still vertical but SSE–NNW aligned. The N part, *c*.0.60m long, was lying horizontally and (roughly) N–S aligned; the W edge of this board was *c*.0.35m from the position of the original side of the cellar.

The remains of the second lowest board were also defined along the N side. The E half of the board (in the NE quadrant) was in two pieces, and had apparently split along the grain of the timber (Plate 3.30). The E end was still vertical and wedged behind the base of the corner-post. Like those around the other sides, the central part of the board had been forced inwards and down and was lying (inner face down) *c*.0.50m (max.) from the *in situ* lowest board along the N side and *c*.0.20m above the cellar floor level. The board marked the interface of burnt deposits below (various discrete burnt deposits and layers) and unburnt sand above, which is the homogeneous brown sand slumped deposit from behind the cellar lining. It sealed material that had already slumped down into the pit from higher up the side, as the upper two boards presumably gave way before this one.

The remains of the same (second lowest) board were also defined in the NW quadrant and the board was shown to lie over the remains of the cellar trapdoor. Like the other boards within the pit, it had been forced inwards and downwards by the slump from behind the lining. The board was still wedged behind the remains of the central post along the N side of the pit and sloped downwards E–W into the base of the cellar, NE–SW aligned and defined for *c*.1.40m x 0.28m wide (max.). However, the W part of the board was less clear. A heavily fragmented timber, *c*.0.40m long (max.), might be the remains of this board. Several short sections of board were also defined in the NW quadrant, lying horizontally but on the same WNW–ESE alignment from the NW corner-post. These are also probably the remains of one or more cellar boards but at least one could be the remains of a floor plank.

The lowest board of the cellar lining, around all four sides of the pit, survived *in situ* (Plate 3.31). The inner-facing sides of these boards (i.e. facing into the cellar) had been heavily charred while, in contrast, their outer faces were unburnt and intact. In places, however, the boards had split longitudinally along the grain of the timber and several had curled inwards as a result of the intense heat and burning on their inner faces, which would have weakened their structural integrity. The top part of the lowest board along the E side of the pit, in the SE quadrant, had simply sheared off; the snapped end was *c*.0.40m from the lower *in situ* part of the same board. Similarly, along the S side, the top part of the lowest board had also split away. Again, the snapped end was *c*.0.35–0.40m from the *in situ* part. A number of other charred timbers in the pit could also have been the remains of cellar lining.

Evidence of accumulation below a suspended floor: deposits on the base of the cellar and on the internal ground surface

The lowest deposits in the pit relate to the construction and also use of the cellar. These were defined below the remains of the collapsed superstructure, *c*.0.10–0.15m thick (Figs 3.2 and 3.3). However, neither the interface between the accumulation and destruction, nor that between construction and use, was easily defined because the superstructure had collapsed down onto, and in some cases through, the accumulation layer. For example, pot-sherds from several vessels that originally stood on the platform above the tie beam at the W end of the building, had become embedded within this layer on the base of the pit (see below). Moreover, the boundary between construction and use was not easily defined because the base of the cellar did not have a prepared floor surface.

The lowest *c*.0.10m of the deposit, directly above the natural (which was *c*.1.45m deep from the ground surface), was a mixed and dirty yellow-brown unburnt sand, with discrete patches and lenses of more compact dark brown sand that are probably the result of trampling and disturbance during construction, and also possibly from the use of the cellar, combined with material that had accumulated below the suspended floor. Finds in this deposit were uncharred because the accumulated sand above insulated it from the fire.

The uppermost part, *c*.0.05–0.10m deep, consisted of fine and very loose black sand above dark red-brown and orange burnt sand. This deposit is probably the result of accumulation during use — of material sifting between raised floor planks and trampling on the base of the cellar[vi]. It contained charred and partially charred finds, and also uncharred finds and, in general, (the remains of) thin objects. The majority of these had been, presumably, accidentally dropped and simply slipped through the gaps between floor planks, although some were possibly deliberately pushed through the gaps. The charred remains of a knife, for example, were recovered from this layer, in the NW part of the pit. This had been dropped at least 19 months before the fire as it was photographed on the cellar floor in June 2003. Alternatively, this and other (larger) items, especially items too large to fall between gaps, might have been accidentally dropped and lost within the cellar during use, rather than falling from the suspended floor; the cellar was principally used by re-enactment groups for storage.

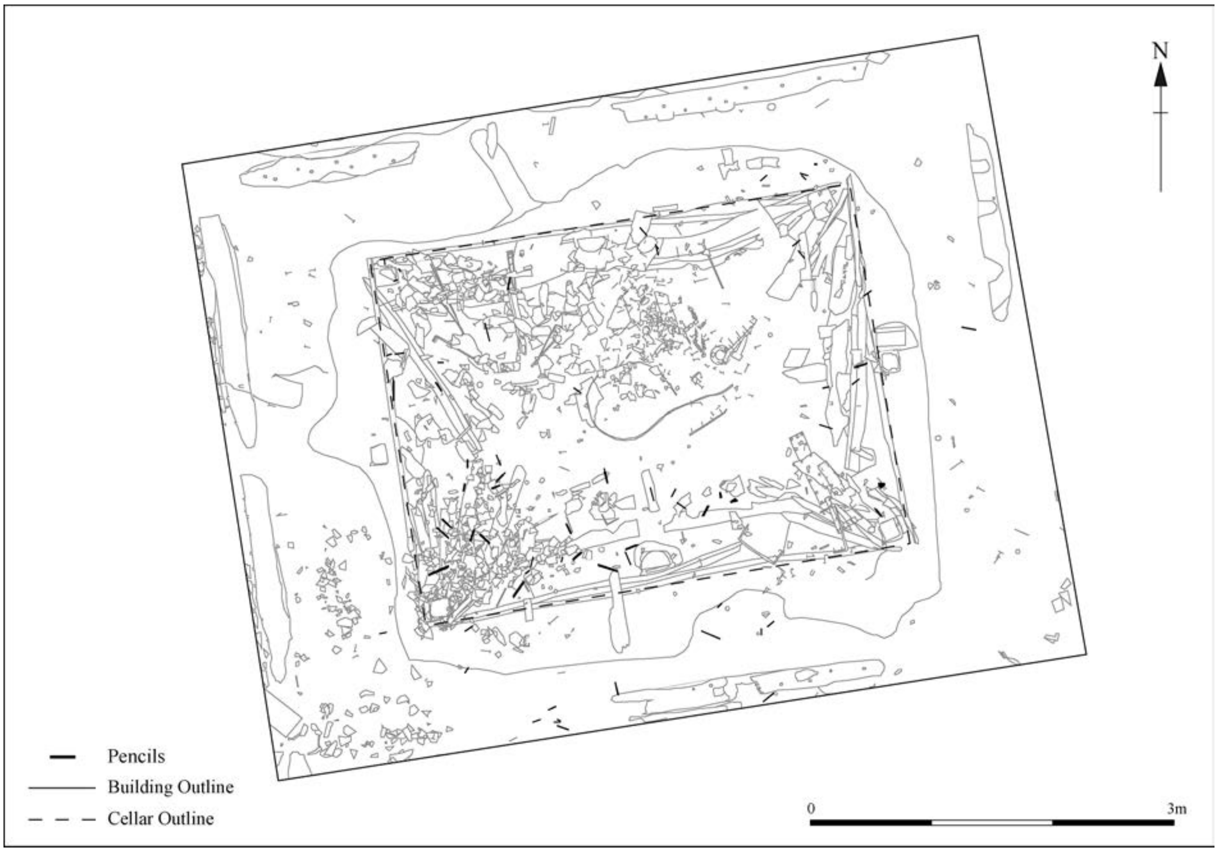


Figure 3.11 Plan of pencils

In particular, the remains of uncharred and partially charred complete pencils were found within the footprint of the building, on the base of the pit and on the ground surface around the pit (Fig. 3.11 and Plates 3.32 and 3.33). These thin objects would have rolled down the gaps between floor boards, dropped especially by school children. They were unable to retrieve them from the base of the cellar, which was inaccessible to the public. However, their alignment was quite random on the base of the pit and while some were aligned N–S, parallel to the floor planks (and the gaps between these), many were not. In explanation, the pencils near the surface of the accumulation deposit might have been disturbed by the timbers that collapsed down into the pit during the fire while others might simply have been disturbed during use of the cellar itself. It is also possible that others simply landed at an angle. There were also many others incorporated within or above the collapsed remains of the cellar lining. These pencils must originally have been on the surface around the upper edge of cellar, brought into the pit with the collapse of the lining.

As well as ten complete pencils, there were also many broken pencil (graphite) leads, and presumably the wood surrounding these must have been completely destroyed. However, many fragments of charred pencil wood were also recovered, often still attached to graphite. In some cases the intense heat has melted the glue (which held the two pieces of wood together) and the wood, entirely charred, has contracted and warped out of shape.

130 pencil lead fragments, ranging from short fragments to ten complete pencils, were recovered from the excavation measuring 7,988mm in total length[vii]. It is difficult to estimate the original total number of pencils, because of the fragility of the leads. Taking the length of a pencil to be 175mm (max.), an order of magnitude can be estimated of 38 pencils (min.) for the fragments. This gives a total of 48 pencils (min.), including the ten complete pencils, although it is likely that the total was higher as some could have been shorter than 175mm.

Perhaps surprisingly, even within the cellar pit, some pencils survived the fire and were totally uncharred (Plate 3.33). These also occurred in association with many pencil leads, where the wood had been completely destroyed. One complete pencil, located against the lowest *in situ* lining, had one side entirely uncharred (presumably the lower side) and the other side charred and partially destroyed. This evidence demonstrates how objects from the same area of, and at the same level within, the pit had different levels of survival. However, the uncharred and complete pencils were all close to the edge of the pit, while the single uncharred pencil on the ground surface was close to the outer joist. These were protected from the fire, presumably because of a greater accumulation of material, and less disturbance, against the sides of the cellar and against the outer joist.

Although it is difficult to be certain how many pencils were originally on the base of the cellar pit, because of the difficulty of distinguishing the interface between the collapsed and cellar-floor deposits (see above), there were at least 47 leads (3,516mm) on the base. Fifteen of the pencils or pencil fragments (1,186mm) were recovered from the ground surface, rather than within the pit, which had been protected beneath the suspended floor. Eleven of these were from the area of the door and window, on the S side of the building. There were many others incorporated

Plate 3.32 The charred pencils on the base of the cellar in the SW quadrant (viewed from S)

Plate 3.33 The uncharred pencils protected by subsequent accumulation below the level of the burning on the base of the cellar in the SW quadrant (viewed from S). There was a Desktop HB pencil complete with rubber located close to the W side (<0.10m) of the *in situ* cellar lining. There was an 'Independent on Sunday' pencil against the S side of the *in situ* cellar lining and also a 'Disco Nite' pencil close to the same side; this pencil was scorched and broken into several pieces but otherwise complete. In addition to the three uncharred pencils from the SW quadrant, there was the remains of a heavily charred but otherwise complete pencil, also on the base of the cellar in the same quadrant but recovered in the sieve

within or above the collapsed remains of the cellar lining, which had also originally been on the ground surface.

Some objects might have been thrown in through the open trapdoor, as an easy way to dispose of rubbish, or possibly lost accidentally. Many nails, screws, staples and tacks were recovered from the base of the cellar, clustered below the position of the fire-box; these came from off-cut timbers used on the fire from building projects relating to the Visitor Centre and Museum. Nails were removed from the ashes by staff and often dropped below the floor as an easy and convenient way of disposal, to hide them from visitors.

In addition to the pencils and nails, the finds on the base of the pit included sweet and food wrappers, several hair slides, a plastic bag, a wine cork and several bottle caps, 11 coins (see below), numerous pot-sherds (see below), glass sherds, a knife (with charred wooden handle), an antler pot-stamp, fragments of bone, a peach stone, a charred fir cone, wool and wool thread, string and tarred twine, a fragment of fabric, a ring, a badge and a crucifix, a glass marble and a bead. Most of these objects presumably fell between the floor planks but some might have been incorporated within the construction layer.

Combustible material, particularly straw from the thatch, had also accumulated on the base of the cellar, and below the suspended floors in the other SFBs. This was periodically removed because of the potential fire hazard, due to modern health and safety regulations. Unfortunately, this was not closely recorded and the extent of this material prior to the fire is unknown within the cellar; at least, it had been disturbed and raked out five months before the building was destroyed, following an earlier accidental fire in September 2004. The base of the fire-box, which had been made with ply, burnt through and the floor planks immediately below caught fire. This resulted in extensive charring to the floor planks immediately below and, consequently, several large gaps between floor planks (Plate 3.34). Ironically, this recent fire had led to a review, and increased awareness, of fire safety in the Village.

Accumulation took place on the base of the cellar and there was evidence of slight ridges of material against the side of the cellar lining. The evidence of these ridges was defined by the char pattern on the lower part of the lowest,

Plate 3.34 The charred floor planks below the fire-box as a result of a fire in September 2004. Notice the gaps between the planks through which small objects fell

in situ plank lining on the S side of the cellar (Plate 3.35). The profiles of at least six or seven low ridges were defined, *c*.0.30–0.40m apart and *c*.0.05m high; those in the central part, in line with the doorway, were up to 0.12m high.

The ridges were observed during phosphate sampling on the cellar floor in June 2003, along with a large number of pencils and other objects (Milner 2003). However, other than the char pattern on the plank lining, the ridges were not defined during excavation. It is possible they were destroyed by the remains of the superstructure, and spoil from behind the lining, which collapsed into the base of

Plate 3.35 The char pattern on the lowest plank lining on the S side of the cellar, which had been in line with the doorway

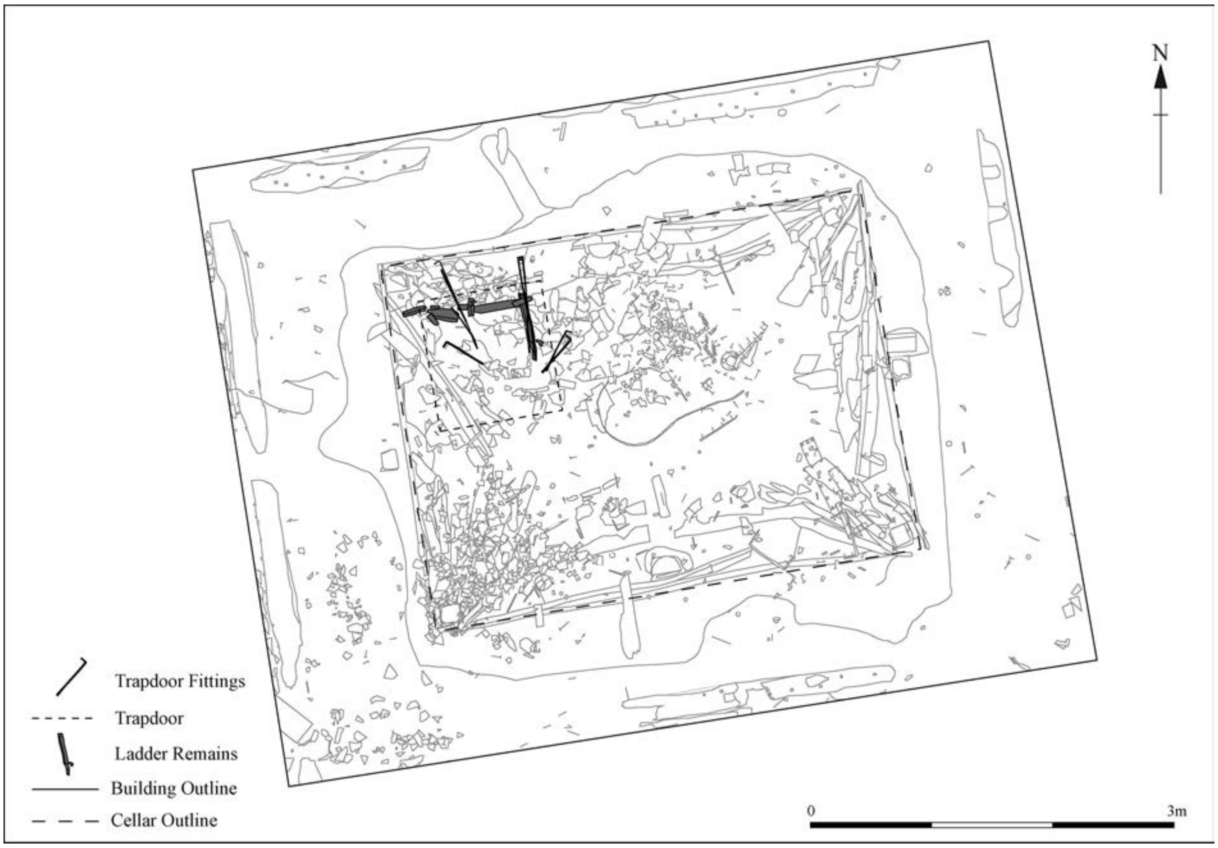


Figure 3.12 Plan of surviving charred step-ladder remains and trapdoor remains on the base of the cellar

the cellar. The cellar was also accessible and used for storage and, combined with the disturbance caused by the earlier fire, much of this material had been probably dispersed already in a more general layer across the central accessible area prone to trampling and greater disturbance. That stated, the ridges of sand clearly accumulate quite rapidly, demonstrated by the formation of distinct ridges of grey-brown sand across the base of the cellar in the replacement Farmer's House. The ridges were already *c*.0.05m high in October 2009, 18 months after the replacement building was completed. In comparison, pronounced ridges of sand, along with a variety of objects, have formed below the suspended floors in the closed off and protected sunken features within both the Living and Weaving Houses (Chapter 7).

Prominent parallel ridges of fine unconsolidated sand, N–S aligned, had also formed in the protected space below the gaps between floor planks at ground level, immediately inside the doorway. They were not seen elsewhere around the upper edge of the cellar at ground level. The entrance area of the building experienced the highest level of foot traffic and thus accumulation beneath the floor planks; sand carried inside the building on the soles of shoes was deposited in the area immediately inside the doorway. Moreover, the buildings were regularly swept out and the material was brushed towards, and out of, the door, hence the likelihood of accumulation would have been much greater directly below the entrance area. In addition, much of the remaining wall space was not regularly accessible due to the position of furniture (bed, benches, chest).

The ridges of material below the entrance reached to the top of the floor joist, which was 0.20m high. Perhaps surprisingly, they were clearly visible immediately after the fire (Plate 3.18), and must have been protected beneath the suspended floor when the different elements of the superstructure collapsed. They were less apparent four weeks after the fire, although they were still visible and there was no appreciable change between March and early June. By the time of the excavation, a month later, the ridges had completely disappeared, flattened as a result of weathering and probably also as a result of animal disturbance. Nevertheless, the deposit of fine material that had filtered below the floor was still defined as a discrete surface layer.

The original extent of these ridges (and troughs) was also clearly defined by the char pattern on the N (inner) face of the floor joist directly below the doorway (Plate 3.20). The ridges of material had protected the face of the joist from burning, producing distinctive V-shaped burn marks in the troughs between ridges. The profile of two V-shaped ridges was defined as scorch marks, with their peaks *c*.0.50m apart and *c*.0.20m in height (max.).

Cellar step-ladder and trapdoor

The fragmentary and heavily charred remains of the step-ladder and trapdoor were defined on the base of the cellar. The N side of the ladder was best preserved because it had been sealed below the collapsed cellar lining while the S (inner) side had been almost totally destroyed (Fig. 3.12 and Plate 3.36).

The remains of the N leg of the step-ladder were partially defined, located *c*.0.40m from the *in situ* cellar lining. The surviving timber measured *c*.1.40m long, aligned E–W. It is possible that a short section of carbonised timber, 0.22m long and E–W aligned *c*.0.70m to the S of this, could be the remains of the other leg but it was too fragmentary for this to be established with certainty.

The remains of two steps were defined, including the charred pegs that held them in place. The lower step was the most complete, defined for *c*.0.65m N–S. Only a short length of the middle step was defined, measuring *c*.0.17m N–S, where it had been attached to the leg. The lining along both the N and W sides of the cellar had collapsed down and across the step-ladder, almost completely destroying the W and S parts of the ladder.

The iron rods that had been threaded through the planks of the trapdoor were spread across an area *c*.1.05m E–W and aligned principally N–S (but also NE–SW and NW–SE). They lay directly above the remains of the step-ladder. Several were bent, presumably as other parts of the superstructure crashed down from above and landed on top of them. Four U-shaped nails/tacks were still fixed around the end of one rod, which had been bent around the edge of the trapdoor. A group of other nails within this area might also have been fixed to it.

Short and very fragmentary lengths of a carbonised plank (or planks) in this area were probably the remains of the trapdoor. It seems possible that the fragmentary remains of a carbonised timber, measuring *c*.0.85m long x *c*.0.10m wide and aligned E–W, could be the remains of the joist that supported the N side of the trapdoor. There was a spread of charred plywood fragments below the iron rods, across an area *c*.1.10m E–W by *c*.0.65m N–S; a sheet of plywood had been attached to the underside of the trapdoor. It was located *c*.0.15m to the N of, although at a higher level to, the surviving step-ladder leg.

Plate 3.36 The remains of the cellar ladder lying on the base of the cellar (viewed from N). The remains of the lowest step, aligned N–S, is clearly visible along with most of the N leg, aligned E–W. Several of the iron fixings from the trapdoor are lying across the top of the ladder remains immediately to the W of the position of the central step, demonstrating that the trapdoor simply collapsed down on the ladder. In addition, the collapsed cellar lining, from the W side, lies at an angle across the top of the ladder

IV. Material culture assemblages

A large number of finds were recovered from the excavation, both within the pit (on the base of cellar and within the side collapse), and on the ground surface, both inside and outside the wall-line of the building. The location of most finds (over 1,000 individual objects) were three-dimensionally plotted during the excavation, along with the charred timbers. However, a considerable number of others were recovered in the sieve.

The total included over 500 sherds (21.5kg) of (both original and replica) pottery, over 2kg of bone and over 130 fragments of pencil graphite. Along with the replica pottery (see below), a small assemblage of authentic pottery was recovered, including 17 (possibly 18) sherds of Roman pottery, 56 (possibly 57) sherds of Iron Age/ early Anglo-Saxon pottery, two sherds of possible Ipswich ware and a single possible sherd of Thetford ware. All except four were recovered from within the pit. These had presumably been incorporated within the re-instated topsoil after the original excavations were completed.

Twenty-three coins amounting to £4.17 were recovered (19 were less than 50p in value)[viii], presumably all the result of accidental loss. Those with identifiable dates (21 coins) ranged from 1981 (1p) to 2002 (10p): six from the 1980s, 13 from the 1990s and two from the noughties. All 23 had been lost below the suspended floor and all except three of the coins were from within the pit[ix]. Eleven coins were recovered from the base of the cellar. A further three were close to the base, but probably within side collapse, while five were definitely in the side collapse; these eight coins were originally on the surface below the suspended floor, brought into the pit when the cellar lining collapsed inwards. There were three coins, amounting to £1.55, on the surface, inside the wall-line, two in the SE corner of the building (1992 5p and 1984 £1) and one close to the door (1997 50p).

In addition to the artefacts, a large assemblage of carbonised insect remains was recovered, especially from the base of the cellar, below the level of the collapsed floor planks. These are discussed in Chapter 5. These were, therefore, within the building and probably in the cellar at the time of the fire, although some could have fallen from above. There were also the remains of heat-altered or toasted and also unaltered insects from the higher collapsed remains, principally from the material behind the cellar lining, which collapsed down and into the pit when the lining gave way. In both these cases, the quantity of insect remains was much lower, and they were dominated by outdoor forms. The carbonised remains, principally on the base of the cellar, had a greater range of taxa and, although outdoor forms were abundant, there were also some species likely to have originated within the structure.

Internal fittings and furniture

A group of fittings and furniture from the building, which left identifiable and distinctive remains, are discussed in the following section. These comprise the non- combustible parts that survived the fire and can be traced back to their origin within the building prior to the fire, such as the pot-sherds from a number of vessels or the metal fittings from a chest. It is possible to examine how, and in some cases when, these have been dispersed because their original locations within the building are known and because individual objects were carefully plotted. This further contributes to the understanding of the sequence of destruction. It was, however, impossible to identify many of the wooden items, such as the tables, benches, chairs, stools or the bed that had no metal fittings. These had been

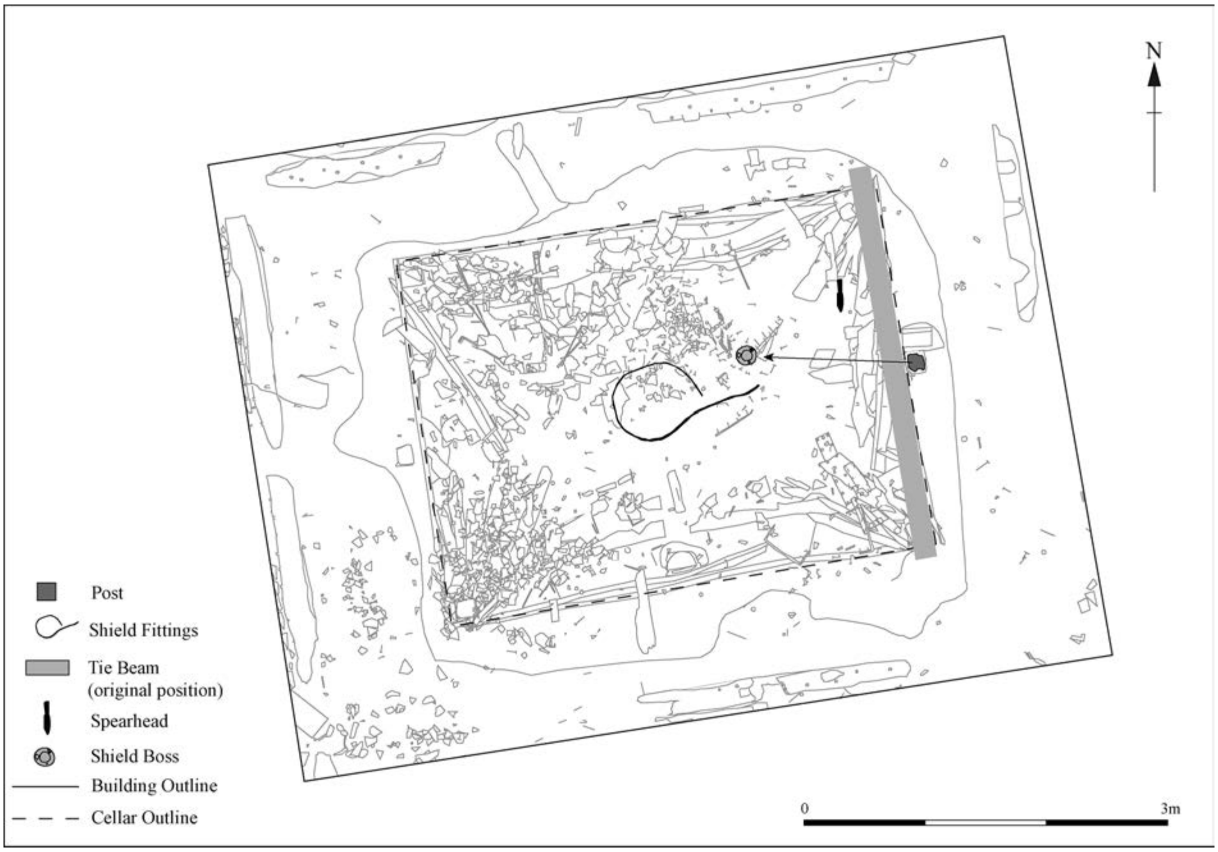


Figure 3.13 Plan showing the location of the shield boss, shield fittings and spearhead (with the original position of the E tie beam, onto which the spear was fixed, marked)

completely destroyed, or at least they were reduced to small and unidentifiable fragments.

Plate 3.37 The mis-shapen fire extinguisher in relation to a reference example

Fire-box and associated features

The remains of the fire-box were defined principally in the N half and on the base of the cellar pit, concentrated in the area directly below where it had been situated. This consisted of large (and small) burnt flint blocks <0.15m long with fragments of (Roman) tile, surrounded by orange burnt sand, which were spread across an area *c*.0.75m wide (E–W and N–S). The flint blocks were sealed below the remains of the collapsed cellar lining from the N side, thus demonstrating that the fire-box had fallen into the pit with the supporting floor planks, before the cellar lining collapsed. The remains of the plank sides and base of the fire-box were not defined.

The iron fire-dog, which stood upright in the fire-box, was defined along the N side of pit, resting at a steep angle against the collapsed cellar lining, although it must have fallen with the fire-box before the lining gave way because the remains of the fire-box were clearly sealed below the cellar lining. This suggests that the fire-dog was still standing in (the remains of) the fire-box and the lining had simply fallen down against the fire-dog.

The cauldron chain was found draped over the remains of a charred (squared) timber in the base of the pit, which is interpreted as part of the N–S floor joist.

Fire extinguisher

The remains of the fire extinguisher were found close to its original position in the SW corner of the building, which suggests that it was not used to try and quench the fire by the person(s) that started it. The canister was found lying across the line of the W outer joist, NW–SE aligned, with the top pointing outwards (Plate 3.9). The upper part of the

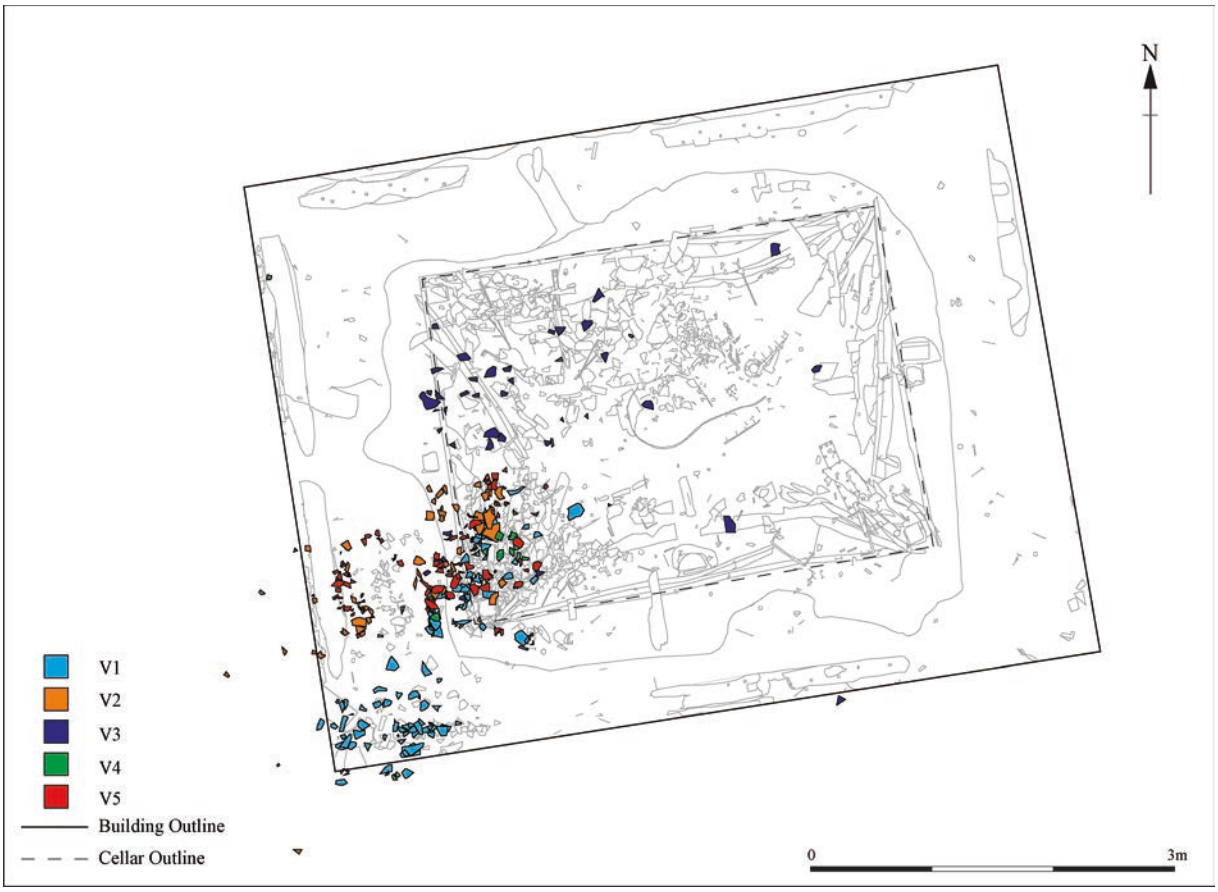


Figure 3.14 Plan of pot-sherds from five vessels

Plate 3.38 The spearhead on the base of the cellar, at the level of the charred floor planks (viewed from W). The charred NE corner-post and the *in situ* lowest planks lining the N and W sides of the cellar, and also the remains of two charred floor planks aligned NE–SW, are clearly defined

canister was bulbous and mis-shapen on one side, indicating its proximity to the heat source, i.e. the swollen side was facing into the building (Plate 3.37; Chapter 6). Other pieces, from the top of the extinguisher, were found in a small area to the SE of it. The pin was found immediately beyond the S wall-line of the building, *c*.0.30m from the handle.

Shield and spear

The shield had been suspended from the E ridge-post, above the lower tie beam (Plate 2.15). The shield boss was located *c*.1.30m to the W of the E ridge-post, to which it had been attached (Fig. 3.13). It was located on top of a piece of tile from the fire-box, which suggests the shield fell onto the remains of the collapsed fire-box. The iron band that fitted around the edge of the shield was roughly central within the base of the pit, across and to the S of the fire-box remains.

The spearhead was found, pointing SW, at the level of the collapsed floor planks in the base of the NE quadrant (Plate 3.38). The wooden shaft had been completely destroyed.

Pottery vessels

There was one complete pottery vessel (Vessel 1 or V1) within the building at the time of the fire, located on the platform in the SW part of the building. V1 was located to the S of the SW corner-post, in the space between the post and the angle of the roof. In addition, there was a second semi-complete vessel V2 on the same platform but on the N side of the same corner-post (Plate 3.9). The rim of V2 had been broken prior to the fire but it was otherwise complete and the broken part was located with the rest of it (Plate 2.17). There were also the fragments of three other vessels (V3, V4 and V5), broken during use, which had been collected and stored on the platform next to V2 (Figs 3.14–3.19).

V1 was a large pale grey wheel-turned storage vessel, with incised line and dot decoration around the shoulder

Plate 3.39 Pottery vessel V1 after refitting (left), which was one of a pair of large storage vessels. The complete example is located in the Weaving House

Plate 3.40 The location of pot-sherds (from V1, V2 and V5) amongst the burnt structural remains on the base of the cellar in the SW corner (viewed from NE towards the *in situ* SW corner-post). The sherds must have been deposited before the cellar lining collapsed in because they were sealed below the remains of the lining

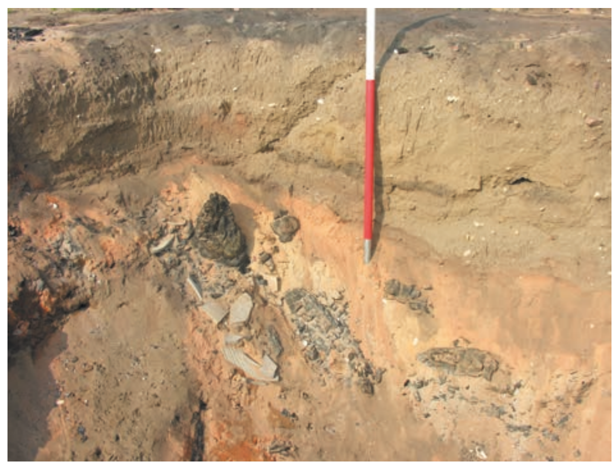
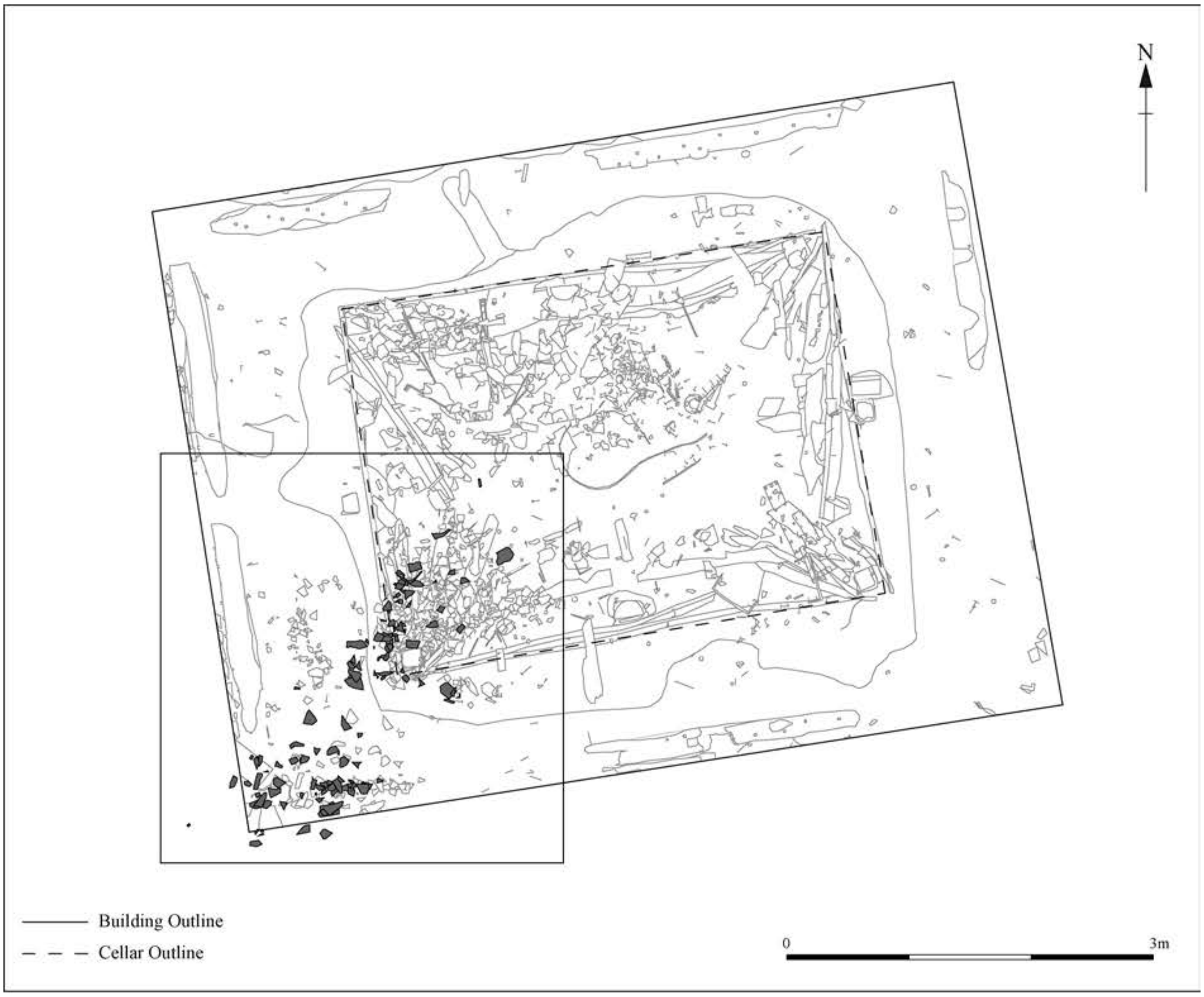


Plate 3.41 The location of pot-sherds from V1 sloping down the collapsed side in the SW part of the cellar pit, in front of the charred end of the *in situ* SW corner-post (viewed from NE). The sherds must have fallen initially onto the ground surface, entering the pit when, or after, the cellar lining collapsed in

(Plate 3.39). There were 151 sherds (*c*.8.60kg) in total recovered from this vessel, of which 128 sherds were plotted three-dimensionally.

The sherds from this vessel were separated *c*.3.70m horizontally (max.) and had a pronounced SW–NE alignment (Fig. 3.15). Most joining sherds were close together but some were over 2.00m apart and there were many joins between sherds within the pit and on the ground surface around it. 63 sherds occurred on the surface around the SW corner of the pit, mainly within the wall-line and directly below the original location of the vessel but several were on or outside the wall-line along the S side of the building.



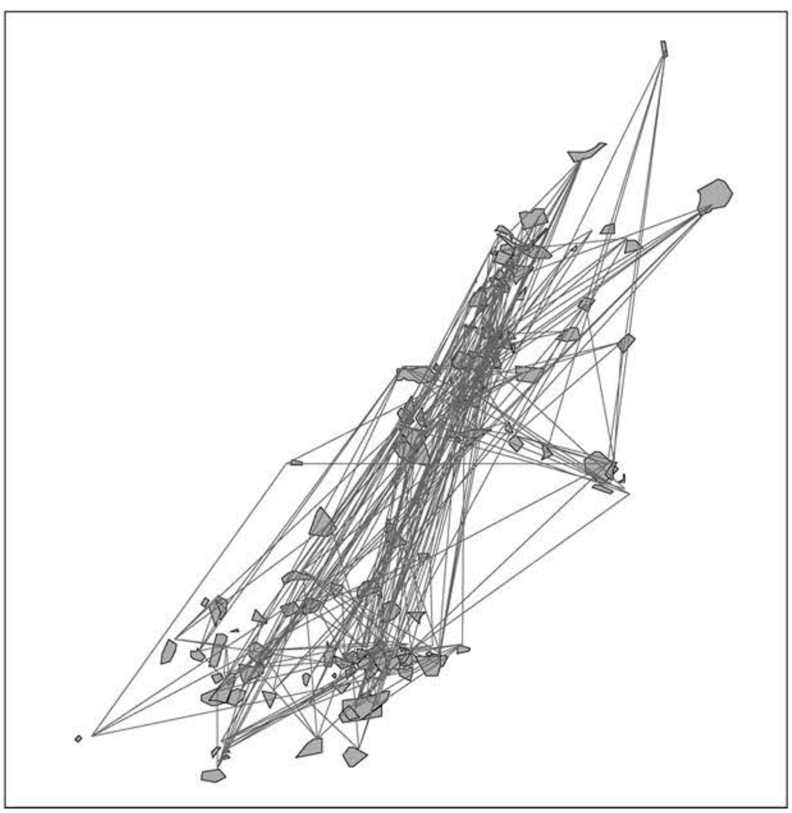
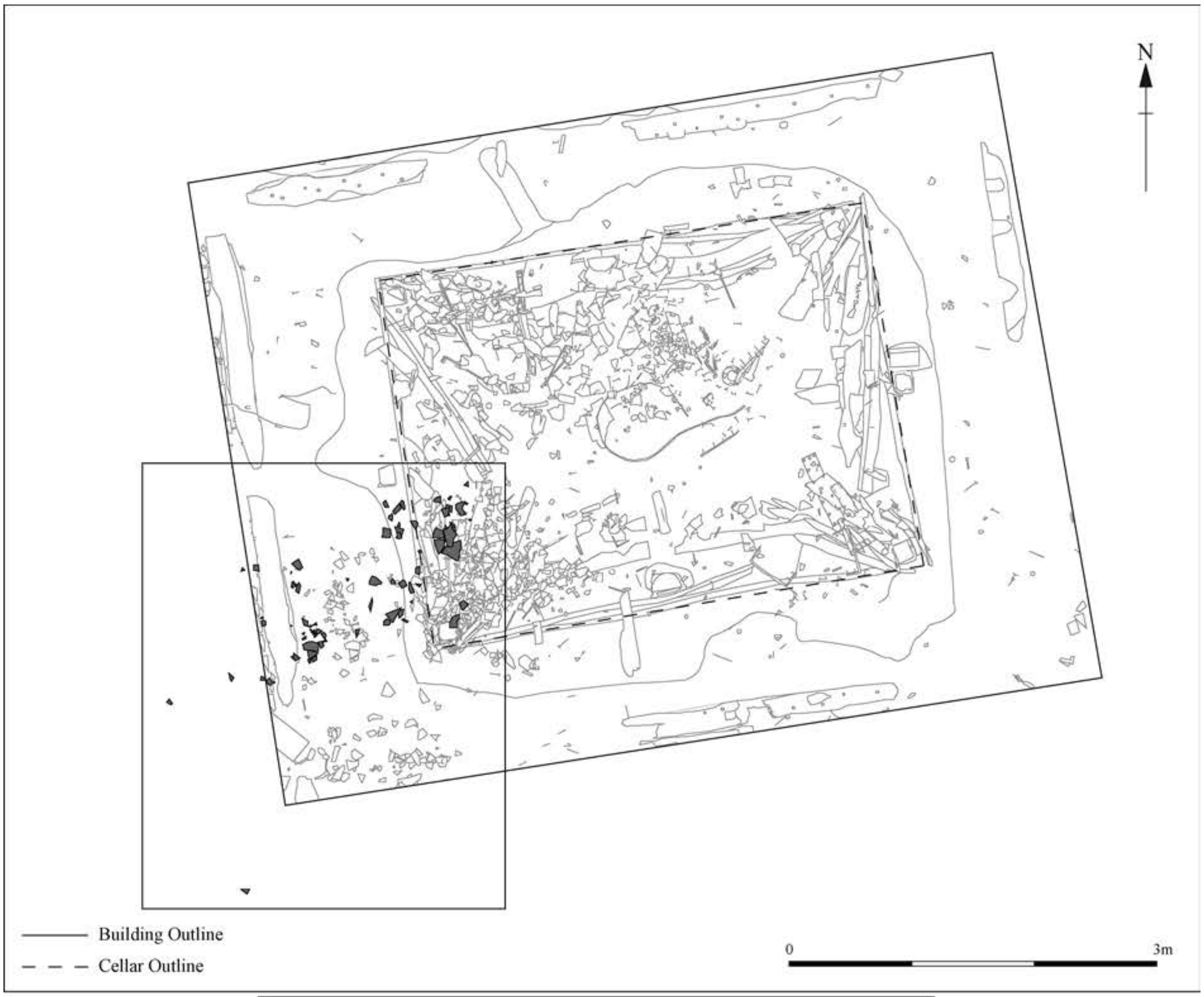


Figure 3.15 Plan of (above) pot-sherds and (below) refitting (lines linking joining sherds) V1, a large storage jar 350mm tall and with a rim diameter of 340mm (base diameter 270mm)



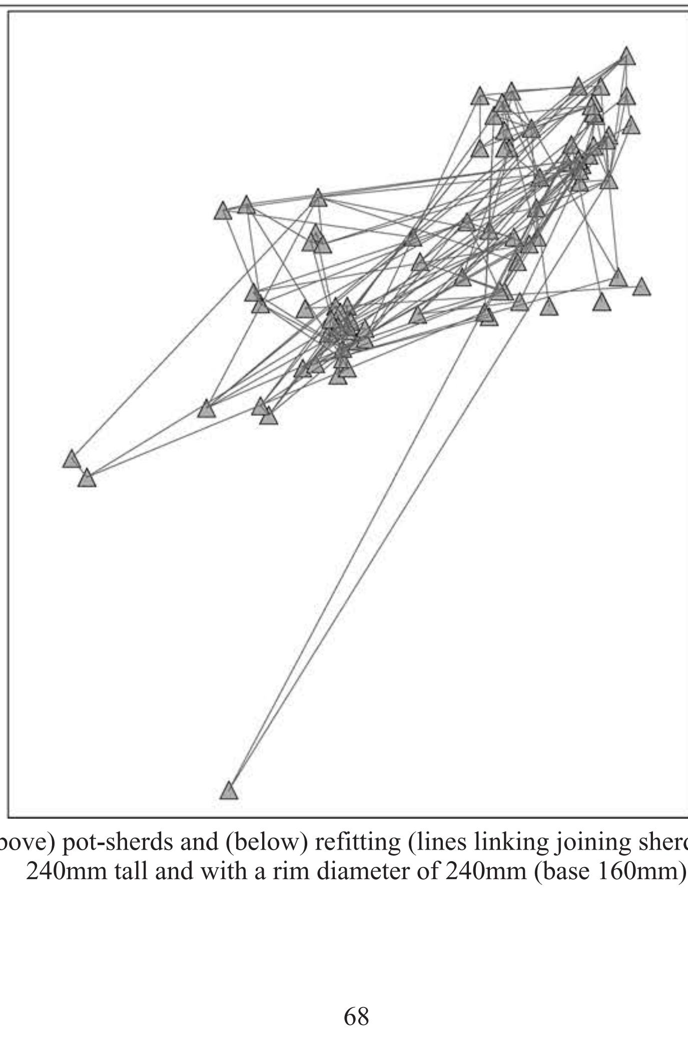


Figure 3.16 Plan of (above) pot-sherds and (below) refitting (lines linking joining sherds) V2, a large storage jar 240mm tall and with a rim diameter of 240mm (base 160mm)

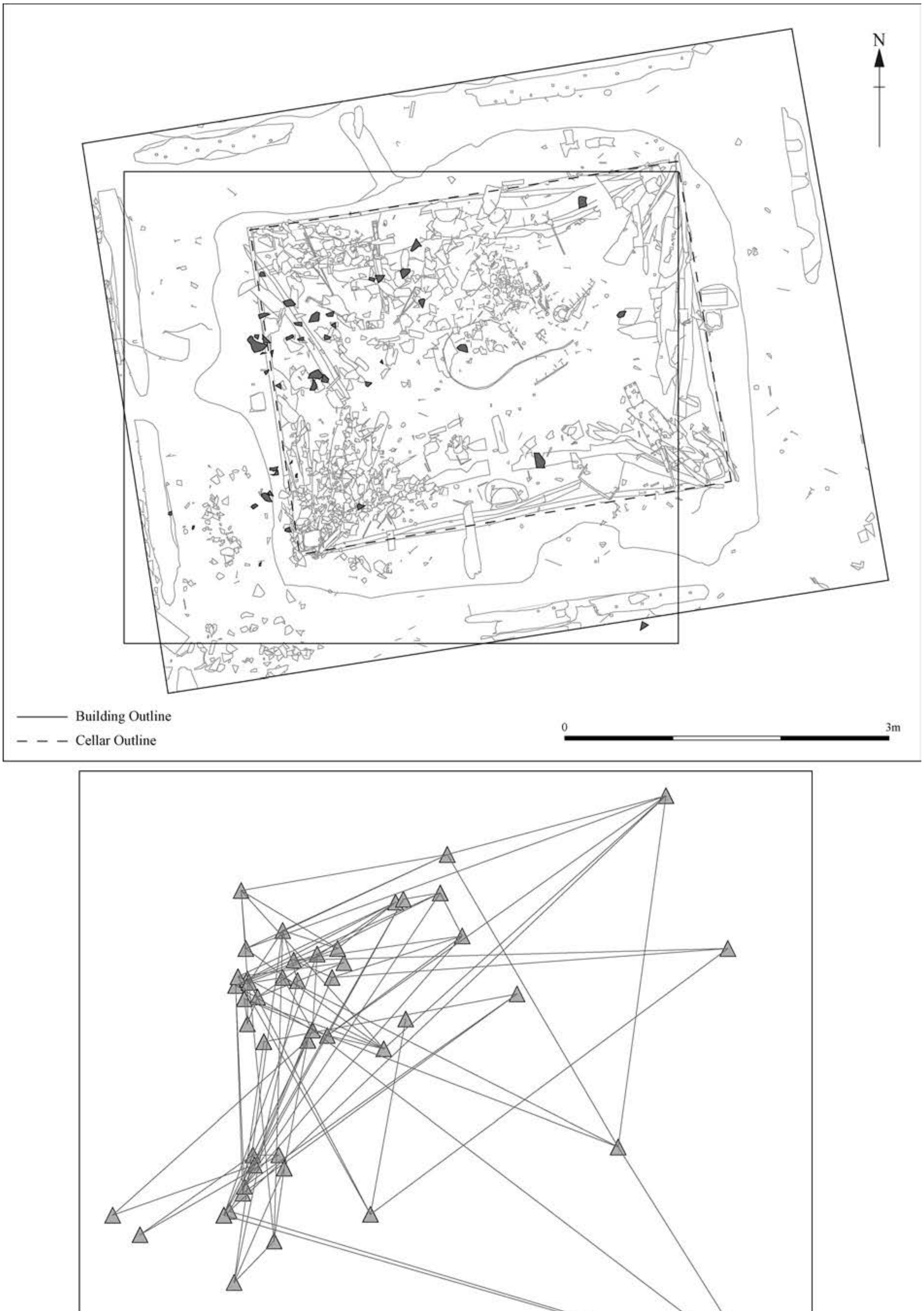


Figure 3.17 Plan of (above) pot-sherds and (below) refitting (lines linking joining sherds) V3, a rusticated bowl with upright pierced lugs 190mm tall and with a rim diameter of 200mm (base 150mm)

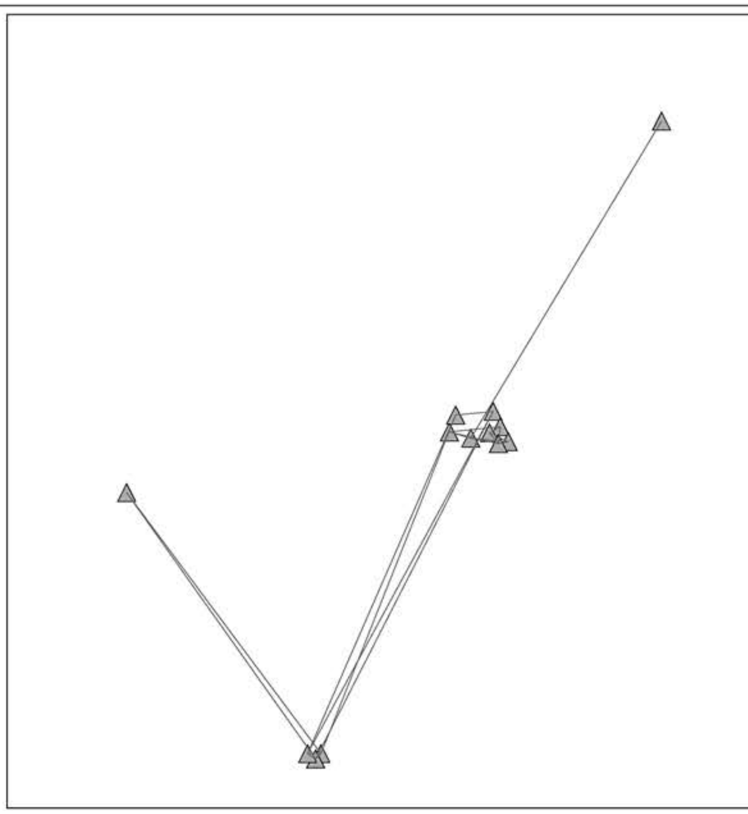


Figure 3.18 Plan of (above) pot-sherds and (below) refitting (lines linking joining sherds) V4, a small storage vessel at least 140mm tall and with rim diameter of 140mm

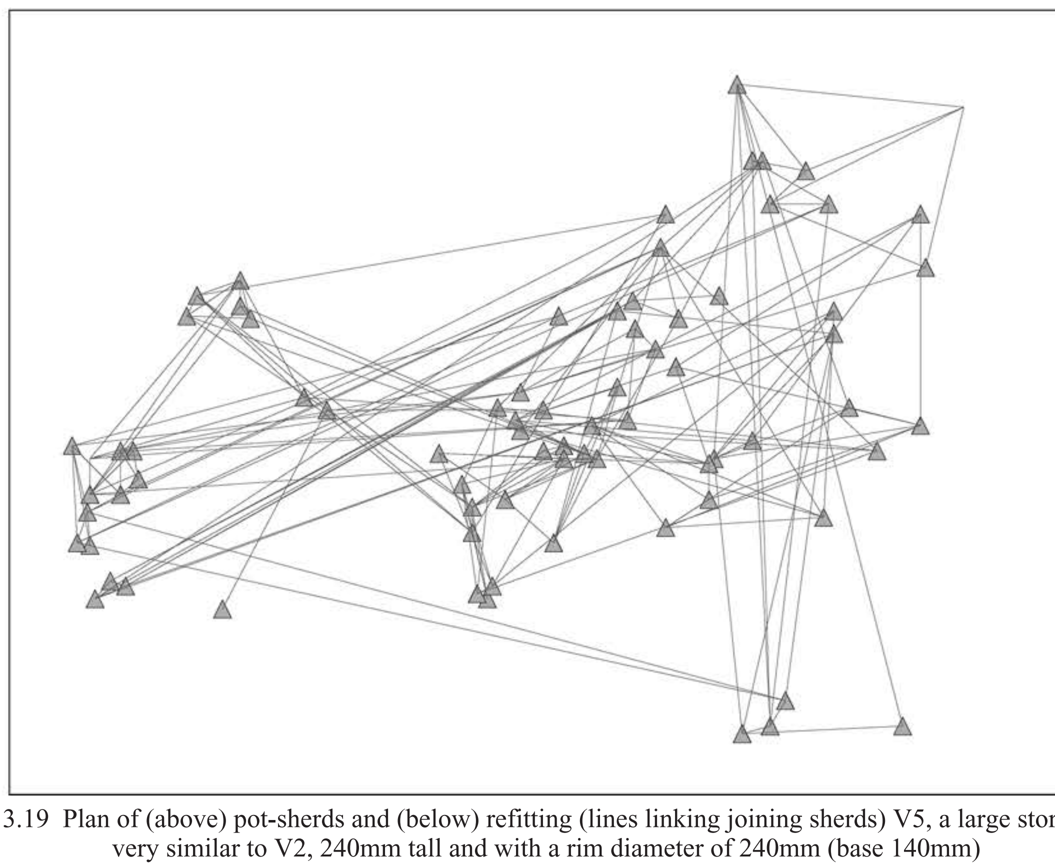


Figure 3.19 Plan of (above) pot-sherds and (below) refitting (lines linking joining sherds) V5, a large storage vessel very similar to V2, 240mm tall and with a rim diameter of 240mm (base 140mm)

Plate 3.42 Conjoining pot-sherds from (left) V2 and (right) V3, showing the effect on individual pot-sherds of localised conditions of temperature and oxygenation within the fire

The other 88 sherds from V1 were at various levels within the pit. Some sherds were embedded within the material that had accumulated on the base of the pit, below the level of the collapsed floor planks (Plates 3.40 and 3.41). However, sherds were also found throughout the subsequent side-collapse. These had originally fallen onto the ground surface, or onto the floor planks that were then completely destroyed around the outside of the pit, and entered the pit through later erosion and side collapse. A number of sherds had slipped down behind the corner-post, after the cellar lining had collapsed; one was wedged between the post and the lowest *in situ* cellar lining. Several others had fallen down a large crack in the side of the pit.

98 sherds (*c*.4.20kg) were recovered from V2, a large red-brown storage vessel with incised linear decoration around the neck. The distribution of sherds from V2 was similar to V1, although their alignment was more E–W; there were two distinct, but overlapping, concentrations of sherds from each vessel (Fig. 3.16). Again, many sherds were on the ground surface (40 sherds in total) within the interior of the building. However, two were *c*.0.50m outside the wall-line on the W side of the building and one was located *c*.0.60m beyond the SW corner of the building and away from the main concentration of sherds. The others were recovered from contexts within the pit, concentrated in the SW corner and at various levels. There were also many joins between sherds within the pit and on the ground surface around it. Most joining sherds were close together but some were as much as 3.20m apart. Like the other vessels, joining sherds had been subjected to different, and localised, conditions of temperature and oxygenation after breakage (Plate 3.42).

There were also 49 sherds (*c*.2.70kg) from V3, a rusticated vessel with two upright pierced lugs. The sherds from this vessel were more widely dispersed and up to *c*. 4.75m apart horizontally (Fig. 3.17). All except three sherds were from the base of the cellar and they were recovered from all four quadrants, but concentrated mainly in the NW part. There were also two sherds on the ground surface in the SW part of the building, amongst the scatter of sherds belonging to V2, and a single sherd (46g) outside the wall-line along the S (E) side of the building.

21 sherds (*c*.0.70kg) were recovered from a decorated vessel V4, with incised linear and dot decoration around the neck and shoulder. All except five sherds of this vessel came from within the pit (Fig. 3.18). Of those on the surface, three sherds were outside the wall-line of the building. Three were located on the S (W) side and one on the (S) W side. A further sherd, inside the wall-line, was located in the NW corner of the building. Within the pit, 11 sherds were clustered together in the SW quadrant; two were wedged behind the SW corner-post. Five were from the NW quadrant of the pit. Sherds from V4 were separated by 4.45m (max.).

114 sherds (*c*.4.90kg) were recovered from V5, a vessel similar to both V2 and V4 with (horizontal) incised linear decoration around the neck. 27 sherds were from the surface with the remainder (excluding five sherds for which there is no record) from the SW quadrant of the pit (Fig. 3.19). Like V1 and V2, the sherds located on the surface were principally along the W (S) side but several were along the S (W) side. Sherds from V5 were separated horizontally by up to *c*.2.00m.

The sherds from V3, in particular, and also V4 were more dispersed across the remains compared to those from Vessels 1, 2 and 5, which formed relatively discrete clusters in the SW corner of the building. These vessels were broken prior to the fire and the evidence suggests that at least some of these sherds had been dispersed across the base of the cellar prior to the destruction of the building; presumably only some of the sherds were collected up and stored on the platform. Unfortunately, there is no record of when and where these vessels were broken. However, a large and distinctive rim sherd from V3, with an upright perforated lug, was recovered from the SE part of the pit, below the level of the collapsed cellar lining. This sherd was also noted on the base of the pit in June 2003 during phosphate sampling (Milner 2003, fig. 3), which at least provides a date before which it must have been broken (*terminus ante quem*).

Wooden chest

There were two wooden chests within the Farmer's House. A small chest, with leather straps for hinges, had stood along the N wall of the building, next to the bed. There was no evidence of this chest amongst the burnt remains, although no detailed spatial analysis has been undertaken on the nails given the very large number recovered (over 500 nails/screws).

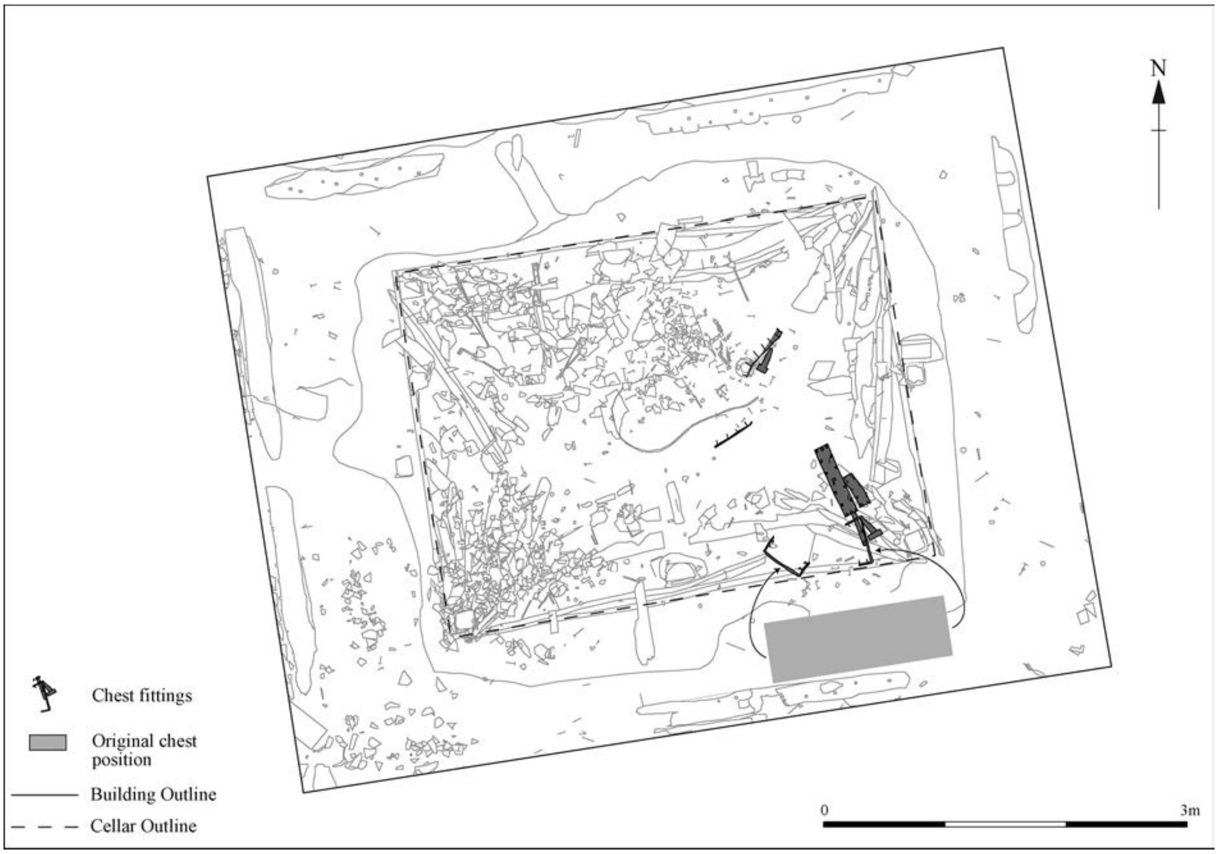


Figure 3.20 Plan of metal chest fittings in the SE part of the cellar pit (with the original position of the chest against the S wall-line marked)

The second chest had been located along the E side of the S wall. It measured *c*.1.50m long x 0.50m wide x 0.50m high and was made from one-inch-thick oak boards fixed together with metal rivets. It had a number of distinctive metal fittings: a large lock plate, two base straps and two lid straps, two reinforcement base plates and also two hinges (Plate 2.16). The boards were completely destroyed and left no trace. However, the distinctive metal fittings survived the fire and were clearly identifiable. These had been strewn several metres apart, presumably separated by the force of collapsing timbers that struck the chest and also by subsequent collapse and erosion (Fig. 3.20, Plates 3.43 and 3.44).

The fittings were located principally in the SE corner of the pit, sloping down on the surface of, and within, the material from behind the lining that collapsed down into

Plate 3.43 The distribution of several metal chest fittings (principally the two base straps) on the surface of the side collapse and sloping down towards the centre of the pit, within the SE quadrant (viewed from N). The top of the charred SE corner-post is just apparent level with the top of the collapse, below the point of the scale bar

Plate 3.44 The distribution of chest fittings (including the lock plate) lying over the collapsed cellar lining (from the S side) in the SE quadrant and sloping down towards the base, and centre, of the cellar. The collapsed lining from both the S and E sides of the cellar is clearly visible, and also the top of the SE corner-post. The planks form a clear division between orange burnt sand to the N and W within the centre of the pit and unburnt sand to the S and E, which collapsed inwards from behind the lining

the cellar. One of two base straps was lying directly over a lid strap and hinge, *c*.1.05m from the original wall-line of the building against which the chest had been placed. The other base strap was at the same level and *c*.0.75m to the W; however, this strap had been hanging down from the top of the collapsed pit side immediately after the fire and only fell into the pit through subsequent side erosion[x]. The lock plate rested against the collapsed cellar lining slightly further inside the pit, sloping down steeply S–N, and next to the first reinforcement base plate (Plate 3.44). The lock plate was also originally on the surface of the collapse, directly below the lid strap, but had been buried by subsequent side collapse.

Several pieces of the chest were recovered from the central (E) part of the pit, on the base and just above the level of the collapsed floor planks. The second lid strap was located *c*.0.90m to the N of the first. The second reinforcement base plate was located *c*.1.60m to the N of the other base straps and underneath the shield boss. It was directly below the second hinge, which was also *c*.1.60m to the N of the other hinge. Both this base plate and the hinge lay to the N of the central axis of the building.

The metal fittings from the chest simply fell down onto the ground surface when the floor planks gave way below it, and subsequently collapsed down into the pit when the lining gave way, because the fittings were stratigraphically above the collapsed lining. This indicates that the remains of the chest did not simply slide down off, or with, the floor planks into the base of the pit, because at least some of the floor planks were sealed below the cellar lining (see above). However, it should not be assumed that all the floor planks burnt in the same way or that they all collapsed down at the same time.

V. Analysis of metalwork

by Vanessa Fell

Introduction

One of the aims of the project was to investigate the effects of burning on a selection of the metal objects, in order to provide a better understanding of high temperature oxidation of metalwork within an archaeological environment (Fell 2007). Only rarely has burnt metalwork in the archaeological record been scientifically analysed (e.g. Fell 2004), although the generally good condition of burnt ironwork has been noted from cremations in particular (e.g. Stead and Rigby 1989, 111).

Methods of analysis

Ten metal objects from the burnt remains were selected at random for analysis to characterise the metal oxidation products resulting from the fire:

- Ferrous items with surface layers in a variety of colours (yellow, red, through to dark grey), in particular a chain. The chain was found draped over the W outer floor joist and on the ground surface within the footprint of the building, but it was originally on the platform at the W end of the building.
- Ferrous items that had been attached to wood or other organic material — the shield boss (Plate 3.45), a hinge from the wooden chest, five nails and a screw. These objects were all found within the cellar pit. The shield had been fixed to the E tie beam while the chest was standing on the suspended floor. The nails and screw were probably all originally on the base of the cellar, below the position of the fire-box, and dropped between the suspended floor planks (see above).
- A non-ferrous brooch on the base of the cellar, lost below the suspended floor.

Corrosion layers of different colours or texture were targeted for analysis using X-ray diffraction (XRD)[xi] and X-ray diffraction analysis (XRF)[xii].

Results

The results of the XRD analyses are summarised in Table 3.3. On the ferrous items, the iron oxides haematite, wüstite and magnetite were the commonest oxidation products determined. The iron oxyhydroxide, goethite, was also found on several items.

Zinc oxide was detected on two iron artefacts, the chain and a nail. In the case of the chain, the zinc oxide comes from the yellow-coloured chain-links. The spectra for the chain also produced minor peaks equivalent to aluminium iron vanadium ($AlFe_2V$), aluminium nickel ($AlNi$) and other compounds. Other unusual peaks occurred on the hinge, two nails and on the shield boss. The single copper alloy brooch yielded zinc oxide in the sample investigated.

The three items in which zinc oxide was detected (the chain, a nail and the brooch) were checked by X-ray fluorescence, and were all shown to contain zinc. The brooch was shown to contain primarily copper and zinc, with traces of lead, suggesting that it was a brass.

Discussion

Ironwork

When iron is heated in an oxidising atmosphere such as air it usually forms multi-layered oxide scales comprising wüstite (FeO), magnetite (Fe_3O_4) and haematite (Fe_2O_3), the proportions of which are temperature dependent (Birks and Meier 1983, 75). Below 570°C, a two-layered scale develops consisting of magnetite (the least oxidised phase) next to the metal, and haematite (the most oxidised phase) on the surface. Above 570°C, wüstite forms below the other two iron oxides, next to the metal, giving the sequence: metal, wüstite, magnetite, haematite. These scales increase in thickness particularly at elevated temperatures when the wüstite will form the thickest layer. However, the latter is unstable and tends to break down to iron and magnetite below 570°C under certain conditions, although if wüstite is quenched or rapidly cooled, it can be retained without transformation (Kofstad 1988, 9). It is commonly found in ironworking slags (Wingrove 1970) including archaeological examples where it can be recognised through metallography and by scanning electron microscopy (e.g. Starley 2003, fig. 102).

At West Stow, these three oxides — wüstite, magnetite and haematite — were identified on the chain, hinge, screw and on the shield boss. One or more of these oxides were identified on the remaining iron artefacts except one nail (see below). To some extent, however, the incidence and proportions of these oxides reflect the selective sampling procedure that targeted unusual coloured or textured deposits. Goethite was found on most of the ferrous items and this is a common oxide found on corroding iron (Cornell and Schwertmann 2003). Its presence here, therefore, is not surprising and is very probably due to corrosion in the ground between the fire and excavation.

On two iron artefacts, the chain and a nail, zinc oxide was identified. The most plausible explanation for the zinc on both items is that these were galvanised or otherwise coated to protect the iron from corrosion. In such processes, the zinc serves as an anodic sacrificial metallic coating, and other metals are often added to improve properties, commonly aluminium, tin, nickel and copper-based alloys (Higgins 1973, 427; Shrier *et al.* 1994, 12:55). Very probably, therefore, the unusual compounds detected on several of the iron finds (e.g. aluminium, iron, vanadium) can be accounted for by these coatings, which on heating, would probably form a range of oxides.

In the three items with zinc oxide, no other oxidation products were detected and the reason may be that this oxide has strong peaks, like quartz from soil, which can tend to over-ride other minor components (such that their peaks do not show). The yellow colour of the samples removed from the chain, for example, may well be due to the presence of trace amounts of iron oxides.

The project also aimed to investigate whether the presence of organic materials, such as wood and leather, may have had any effects on the nature of the oxidation products that formed on the metalwork. Evidence for this was not found; the fire seems to have swept through the centre of the building, removing wood from all or most composite finds. It would, in any case, not be easily detectable on the items selected for examination because these did not retain any charred organic materials apart from small pieces of charcoal collected within the shield boss, which was upside down on the base of the pit. Oddly, though, insect cuticles did survive on the hinge.

Copper alloy

The brooch was shown to be made of brass. When heated, a brass will melt in the range from 900°C for a 40% brass (wt % zinc) to 1040°C for a 10% brass (Brandes 1983, table 14.4). In brasses of low zinc content (below 10%), oxidation usually produces scales that contain mainly copper oxides, whereas at higher zinc proportions, the scales usually comprise zinc oxide (Kofstad 1988, 357–9). Therefore, the presence of only zinc oxide in the grey surface deposits of the brooch suggests that this was a moderate or high zinc brass that was heated in oxidising conditions to temperatures less than the melting point.

Corrosion after excavation

The ferrous items that were visible in the ground were distinctly red in colour (e.g. the chain and the chest straps) and this colour persisted during exposure to the weather through the excavation, and later until at least November 2006 when the items were returned to the archive. During this 21 month period, some deterioration of the iron was visible — flaking continued on certain items such as the hinge and shield boss, beneath which there was active corrosion. The flaking may be due to the combined effects of active corrosion producing voluminous corrosion products, exacerbated by contraction of surface layers of scale. A sample of the grey scale layer from the boss was tested for likelihood of corrosion by placing in a container of tap water in the laboratory and after 12 months this appears visually not to have corroded.

Conclusions and summary

This project aimed to characterise the metal oxidation products resulting from the fire. As expected, analysis showed that haematite was common, as previously noted by Biek (1963) and other authors. One oxide not normally

Sample (S)	*Object*	*XRD no*	*Results - Major minor (trace)*
1	Chain	5177	**Haematite** (Magnetite)
2		5178	**Quartz, Magnetite, Wüstite**, Zincite, Goethite
3		5179	**Haematite**, Wüstite (Magnetite, Quartz)
4		5180	**Zincite** (unknown*)
5		5181	**Wüstite**, Haematite, Magnetite (Quartz)
6		5183	Magnetite, Goethite, Wüstite (Quartz)
21		5198	**Zincite** (Quartz, unknown*)
7	Hinge	5184	**Haematite, Magnetite**, Wüstite (unknown*)
8		5185	**Magnetite, Wüstite** (Haematite, unknown*)
9	Nail	5186	**Quartz**, Haematite, Goethite, Magnetite
10	Nail	5187	**Zincite**, Quartz
11	Nail	5188	**Quartz**, Maghemite (Goethite, Hematite?, unknown*)
12	Nail	5189	**Quartz**, Magnetite (Goethite, unknown*)
13		5190	**Magnetite**, Zincite, Wüstite (Calcite, Quartz)
14	Nail	5191	**Quartz, Magnetite**, Goethite, Haematite (unknown*)
15	Screw	5192	**Magnetite** (Haematite, Wüstite, Quartz)
16	Brooch	5193	**Zincite** (Quartz)
22		5199	**Zincite** (Quartz, unknown*)
17	Shield Boss	5194	**Haematite**, Magnetite (Wüstite)
18		5195	**Wüstite, Goethite, Lepidocrocite** (Magnetite, unknown*)
19		5196	**Haematite, Quartz** (Magnetite, unknown*)
20		5197	**Haematite, Wüstite, Magnetite**
23		5200	**Haematite**
24		5201	Magnetite, **Wüstite** (unknown*)
25		5203	**Magnetite, Goethite, Wüstite**, Lepidocrocite
26		5204	**Haematite**

Results shown bold for Major components, normal text for minor, bracketed for (trace)
* Traces of uncertain compounds such as aluminium iron vanadium ($AlFe_2V$)

Table 3.3 Summary results of XRD analysis

Plate 3.45 Shield boss. Left, inside the boss; right, outer side

recorded on archaeological artefacts was wüstite, although this is commonly found in ironworking slags. Also found on two ferrous items was zinc oxide, due presumably to the burning of protective coatings that had been applied to the modern iron. Specific oxidation effects were not noted due to the proximity of organic matter in contact with the metalwork. The brass brooch had burnt to produce zinc oxide, which suggests that it had a high zinc content.

VI. Discussion

This chapter has discussed the physical evidence of the Farmer's House remains. The building represents one of only few examples of experimental reconstructions, from any period, to have been destroyed by fire and subsequently investigated in detail. Moreover, it represents the first example of an experimental reconstruction of an early Anglo-Saxon SFB with a suspended floor to have been destroyed by fire. Therefore, it is especially important to the discussion of this specific structural type but also more generally to the discussion of structural fire in the archaeological record; it is for this reason that the evidence has been presented in detail. The knowledge of the original design, presented in Chapter 2, combined with the detailed level of recording, and also supplemented by the images taken during the fire, has allowed for a close understanding of the surviving evidence. In Chapters 4 and 5, the scientific analysis of samples taken during the investigation is presented, which sheds further information on the surviving evidence and the site deformation processes that took place, both during the fire and in the six months between the fire and the excavation. The implications of the results from these scientific techniques, which are now used as standard practice on archaeological excavations, are also discussed.

Endnotes

i The cost of hiring a protective scaffold roof to cover the remains was investigated but proved prohibitively expensive.

ii Rabbit disturbance has been a continual problem to the experimental project at West Stow.

iii There was, however, no identifiable evidence of the purlin within the pit.

iv The surface area of the pit was enlarged slightly, however, as a result of further side collapse during excavation.

v The cellar pit was left open after the excavation was completed and less than two months later, the joist had collapsed into the pit.

vi The gaps between the floor planks were not carefully recorded before the fire.

vii 63 fragments (measuring 2,490mm, i.e. 31% by length of lead) were recovered in the sieve. Many more fragments might simply have slipped through the 5mm sieve.

viii Eleven, amounting to £1.64, were recovered from the sieve.

ix In addition, a single coin (1997 2p) was located outside the (S–) E wall-line of the building.

x It was still hanging down at least a week after the fire.

xi Samples were removed from the artefacts by scalpel and with the aid of a low-power binocular microscope. Samples in the order of 1mg were ground in an agate mortar and mounted on a glass slide. X-ray diffraction (XRD) data were collected on a Philips PW 1840 powder diffractometer using cobalt Kα radiation (wavelength Kα 1 = 0.178896nm, Kα 2 = 0.179285nm) incorporating a solid-state silicon detector. The running parameters were 40kV 40mA for X-ray generation. Data was collected between the angles 7 and 100 °2θ, at step size 0.05 °2θper step, time per step 1 second, with a receiving slit width of 0.30mm. A search-match computer programme was used to identify unknown components in the diffraction patterns by comparison with standards in the powder diffraction file (International Centre for Diffraction Data, ICDD). Initially powder diffraction files database version PDF-1 was employed; later, in 2006, version PDF-2 was used. X-ray diffraction analysis detects only crystalline phases and therefore amorphous components will not be determined. Nevertheless, it is a standard analytical method for determining minerals and corrosion products on archaeological artefacts, as well as numerous other applications.

xii Three items were checked to determine the elements present using X-ray fluorescence (XRF). In two instances (S4 and S10), the powder that had been used for XRD analysis was placed in the specimen chamber; the third item, the brooch, was placed whole in the chamber. These were analysed under vacuum at 40kV, 220µA in an Eagle II X-ray fluorescent spectrometer with a lithium-drifted silicon detector. The results are qualitative and not standardised.

4. The Geoarchaeological Evidence

by Charles French and Karen Milek

I. Introduction and aims

After the Farmer's House burnt down in February 2005, the building was completely excavated four months later. In conjunction with this, a programme of geoarchaeological analysis was instigated. This had three primary aims:

- To investigate the impact of a known fire event on the reconstructed building, specifically the effects of burning on the construction materials that had collapsed into the cellar pit, and the fills that had accumulated in the earthen-floored cellar during the construction and use of the building, and the immediately adjacent natural soils.
- To compare the primary fill of the reconstructed SFB to the fills of other excavated Anglo-Saxon SFBs that have been previously analysed using geoarchaeological techniques. As the construction and use of the reconstruction was well known (see Chapter 2), the analysis of its fill sediments had the potential to provide useful reference material, which would make it easier to interpret how Anglo-Saxon SFBs had been constructed and used.
- To assess the relative value of different geoarchaeological techniques in the analysis of the fills of Anglo-Saxon SFBs and the reconstructed versions of these buildings.

In order to fulfil these aims, a combination of bulk sampling for geochemical and magnetic analyses and undisturbed block samples for sediment thin section micromorphology were taken during the excavation of the Farmer's House. Micromorphological analysis was selected because of its ability to provide detailed information about sediment composition, microstructure and the orientation and distribution of its components, making it the most effective technique for the detailed analysis of fine vertical stratigraphy, the detection of compaction features related to trampling, the identification of minerals that had been altered by the heat of the fire, and the interpretation of site formation processes (Courty *et al.* 1989; Davidson *et al.* 1992). The bulk analytical techniques selected were: the determination of pH, which provides information about preservation conditions related to the acidity/alkalinity of the soil environment; magnetic susceptibility, which is enhanced when iron in the soil or sediment is heated, and therefore serves as an indicator of the relative effects of fire; and multi-element analysis by inductively coupled plasma atomic emission spectroscopy (ICP-AES), which measures the relative concentrations of 34 elements in the soil/sediment, and can therefore provide information about the composition of the pit fills relative to the surrounding soils.

The original sampling design had called for the acquisition of bulk samples from the primary fills on a systematic 0.50m grid, in order to test whether there were any patterns in the multi-element and magnetic susceptibility distributions that could be related to activities that had taken place above the cellar, on the raised timber floor. However, the thinness of the primary fills and the disturbance caused by the collapse of the building's superstructure made this sampling strategy difficult in practice, and consequently bulk samples were taken only from the burnt sand layers adjacent to the micromorphology samples. Control samples of the sandy subsoil were taken for bulk analyses from nearby sandy subsoils at Lakenheath and Thetford, but not from West Stow itself.

II. Sampling

A series of 11 samples was taken for micromorphological and geochemical analyses from the surviving burnt and fill deposits of the destroyed timber building at West Stow (Table 4.1; Figs 3.2 and 4.1). These samples were primarily taken from where split timbers were in direct contact with the underlying burnt sediments, both in the pit and on its upper edge. All but two (samples 7 and 9) of these were analysed in thin section (after Murphy 1986; Bullock *et al.* 1985; Stoops 2003), and 11 associated small bulk samples were analysed for magnetic susceptibility (Table 4.2) and a suite of geochemical analyses (ICP-AES) (Table 4.3) (Appendices 1 and 2). A further series of seven control samples (12–18) of sand substrate from the area were also analysed by the ICP-AES method (Tables 4.1 and 4.3; Appendix 2).

In addition, a series of 13 small bulk samples were taken from the modern topsoil immediately surrounding the Farmer's House for a separate study on the recognition of trampling by Whaley (2008). These were located on the four cardinal compass points immediately outside of the burnt down structure, and were processed for pH, loss-on-ignition (for total organic matter and carbonate contents), magnetic susceptibility and particle size data (Appendix 2).

Methods

Eleven block samples for micromorphological analysis and eleven bulk samples for geochemical analysis were taken from sediments that had accumulated within the cut of the cellar pit. The block samples were taken using aluminium Kubiena tins, most of which were pushed into the sections exposed when the feature was excavated in opposing quadrants (Table 3.1, Figs 3.2, 4.1 and Plate 4.1). In addition, two samples (1 and 4) were pushed down into the bases of the NE and SW quadrants respectively and one sample (5) was taken from the W edge of the pit, across the boundary of the burnt sand and the unburnt natural sand that surrounded the feature. All but two of the micromorphology samples were taken to the University of Cambridge, where they were air dried, impregnated with crystic polyester resin, and thin sectioned following Murphy (1986) (Appendix 1). Note that sample 9 was

Sample	*Location*
1	base of NE quadrant; collapsed and interleaved floor planks and sand (761)
2	E-facing section of NE quadrant; burnt sand at the base of the cellar pit (726), resting on unburnt natural sand (similar to sample 7)
3	on ground surface of N side of the cellar pit; spot sample beneath completely burnt N (E–W) floor joist
4	base of SW quadrant; ?ash (778) and burnt sand (779) at the base of the pit, resting on unburnt natural sand
5	on the west face/side of the pit; burnt infill deposit behind (to the outside of) the cellar lining
6	W-facing section of SW quadrant; lowest deposits below collapsed supersturcture at the base of the pit over unburnt natural sand (later determined to be re-deposited)
7	E-facing section of NE quadrant; as for sample 2, but not processed in thin section due to damage in transport
8	N-facing section of NE quadrant; taken through the highest layer (761) below the collapsed superstructure (912 and 913); comprising burnt over unburnt sand infill lenses in the base of the pit
9	retained by the excavator for other analyses
10	S-facing section of SW quadrant; taken through layers 808, 860 and 900, all below the remains of the collapsed superstructure; comprising burnt, collapsed floor plank over burnt sand over sand infill lenses in the base of the pit
11	as for sample 10; south-facing section of SW quadrant; taken through layers 652, 808, 860 and 900, all below the remains of the collapsed superstructure
12	sand substrate control sample, Lakenheath
13	sand substrate control sample 1, Thetford
14	sand substrate control sample 6, Thetford
15	sand substrate control sample 2, Thetford
16	sand substrate control sample 3, Thetford
17	sand substrate control sample 4, Thetford
18	sand substrate control sample 5, Thetford

Table 4.1 Locations of geoarchaeological samples taken from the Farmer's House

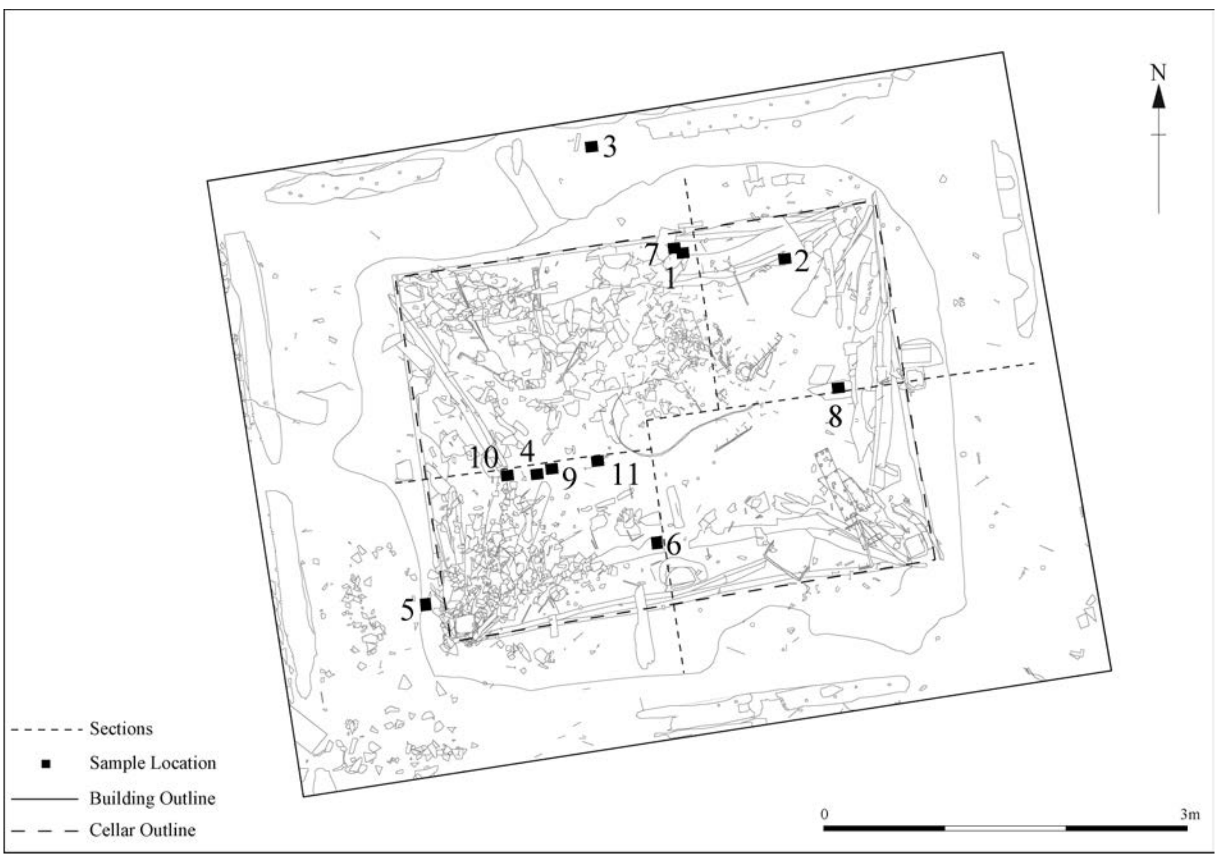


Figure 4.1 Plan of the Farmer's House showing the locations of the soil micromorphology samples

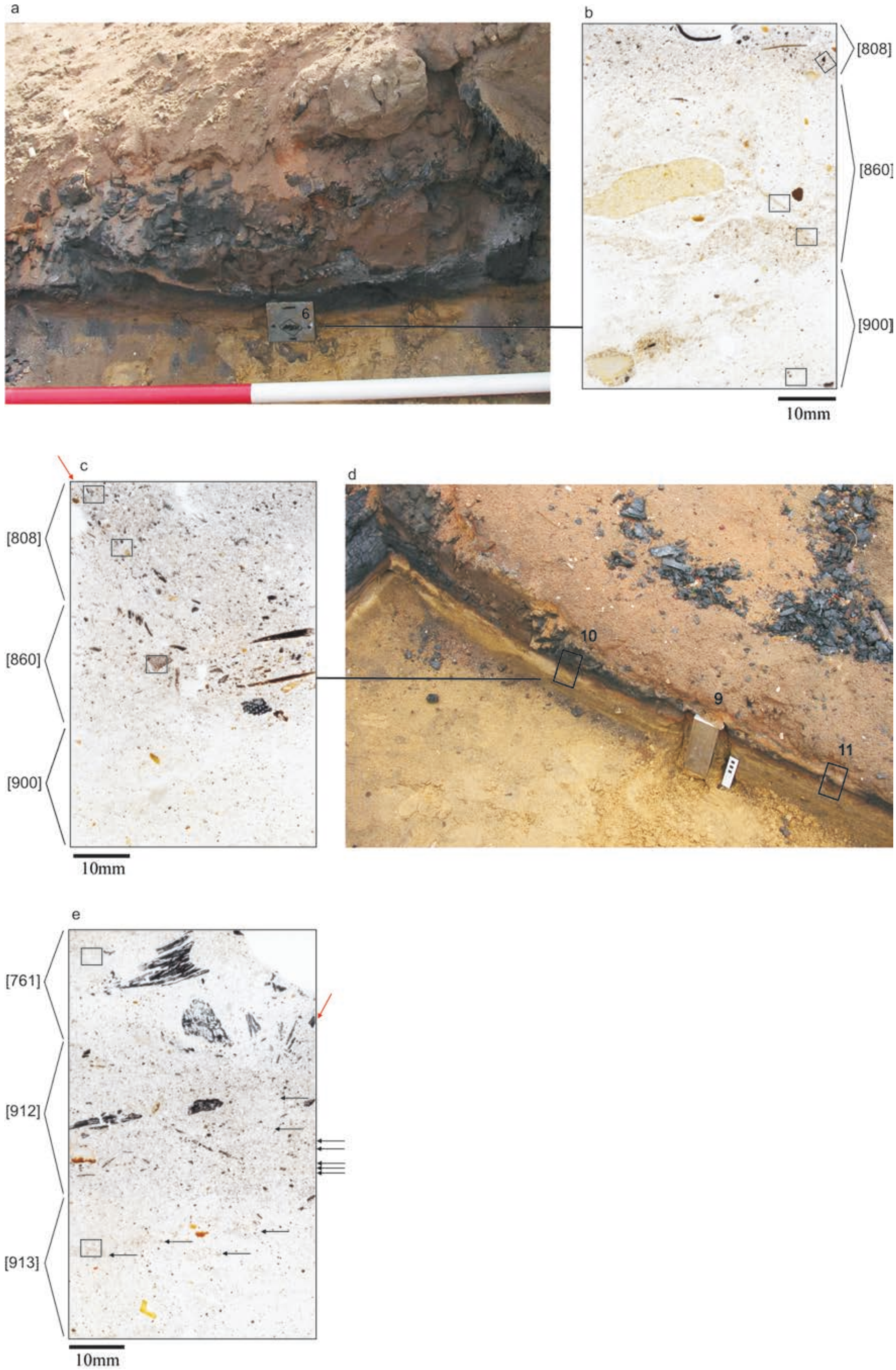


Plate 4.1 (a) Sample 6 being removed from W-facing section 17; (b) Sample 6, with context numbers labelled, showing the locations (from top to bottom) of Plates 4.2a–b, 4.4e–g, 4.2c–d and 4.2e–f. (c) Sample 10, with context numbers labelled, showing the locations (from top to bottom) of Plates 4.3e, 4.3f and 4.3g. The red arrow indicates the angle at which sand and charred organic material slumped into the pit. (d) Samples 9, 10 and 11 on S-facing section 18. (e) Sample 8, with context numbers labelled, showing (at the top) the location of Plates 4.3a–c and 4.4a, and (at the bottom) the location of Plates 4.4b–d. The red arrow indicates the angle at which sand and charred organic matter slumped into the pit. Black arrows indicate multiple, horizontal lenses where there is a greater proportion of silty clay, and which were probably created by trampling on the cellar floor

Sample	*Magnetic Susceptibilty (SI units)*
1	422.8
2	94
3	26.1
4	512.2
5	26.8
6	65.9
7	18.7
8	98
9	17.5
10	309.6
11	98.6

Table 4.2 The magnetic susceptibility values from the Farmer's House

retained by the excavator and sample 7, which was disturbed during transport, was not processed.

The thin sections were scanned on a flatbed digital scanner, studied at a scale of 1:1, and then analysed with petrographic microscopes at magnifications ranging from x4 to x400 using plane-polarised light (PPL), crossed-polarised light (XPL), and oblique incident light (OIL). Micromorphology descriptions were based on the internationally accepted terminology outlined in Bullock *et al*. (1985) and Stoops (2003). The interpretation of thin sections was aided by reference to the experimental and ethnoarchaeological materials collected by the authors and other researchers (e.g. Canti and Linford 2000; Canti 2003), and by the accumulated experience of soil scientists who have been applying micromorphological techniques to archaeological questions (e.g. Courty *et al.* 1989).

Bulk sediment samples of *c*.200ml were taken from burnt sand layers adjacent to the micromorphology samples. They were taken to the University of Cambridge, where they were sub-sampled for two sets of analyses: magnetic susceptibility and multi-element analysis (Appendix 2). Small sub-samples of *c*.20ml were sent to ALS Chemex in Canada for multi-element analysis by ICP-AES. This involved air-drying, pulverizing and sieving 5–15g of sediment to remove constituents over 180μm in size. The elements in the sample were then leached using a nitric acid–aqua regia digestion system and the soil solution was heated to a temperature of 800ºC. The light resulting from the excitation of the elements in the sediment was then collected by an atomic emission spectrometer, resolved into a spectrum of constituent wavelengths, measured for its intensity, and converted to an elemental concentration (ppm) by comparing it to calibrated standards.

Whaley's (2008) and our studies used established protocols at the Physical Geography Laboratory, Department of Geography, University of Cambridge, for measuring pH, soil organic content by loss-on-ignition, magnetic susceptibility and laser particle size analysis (Appendix 2).

III. Results

Magnetic susceptibility, multi-element and physical analyses

The magnetic susceptibility (Table 4.2) and multi-element analyses (Table 4.3) revealed variable results which were difficult to correlate to the burning event, whereas the micromorphological analysis (Table 4.4) allowed burnt/unburnt horizons, infills and inclusions to be identified, and sequences of events to be established. It had been expected that high magnetic susceptibility results would reflect the oxidised iron and manganese content (e.g. maghaemite) in the sand substrate concentrated on heated sand surfaces immediately beneath burnt structural timbers, whether they were *in situ* or collapsed. Although the sample set analysed is probably too small to be sure of this relationship, the very high magnetic susceptibility values for samples 1, 4 and 10 seem to correlate well with locations where timbers burnt/remained hot for a length of time. In the same situation, one could reasonably have expected similarly high values associated with samples 3, 6, 8 and 11, but these were not enhanced. Rather unexpectedly, these high values were not coincident with high values of iron, but there were high manganese values in all samples (Table 4.3), whether from burnt contexts or the control samples, suggesting that the sand substrate in the area has a naturally high manganese content. The other notable multi-element results were the consistently slightly enhanced phosphorus values (770–1330 ppm) for all of the samples associated with the burnt structure, but not in the control samples (260–350 ppm) (Table 4.3). This must reflect the presence and use of the structure, even though it only had a relatively short life-span of 10 years, and was not lived in year-round. This data corroborates the study of Milner (2003) of the cellar floor when the Farmer's House was upstanding which indicated discrete areas of phosphate and carbon enhancement.

From Whaley's (2008) study after the fire, pH values of the modern turf horizon and sand subsoil from the area immediately outside the building ranged from 6.3 to 8.5, or circum-neutral to calcareous. There were also irregular patches of enhanced magnetic susceptibility to the S and E sides of the structure, a feature also observed by Harrison's study (see Chapter 7). The organic and carbonate contents of the modern topsoil were very low, generally less than about 2.3% and 2.5%, respectively. In terms of particle size, fine sand predominated with a minor peak of fine silt, thus complementing the thin section analysis.

Micromorphology

The descriptions of the micromorphological samples follow, and are summarised in Table 4.4 and described in full in Appendix 3.

The sampling and descriptive results essentially duplicated a number of circumstances. These samples represent three main types of sequences: (1) an *in situ* burnt floor joist resting directly on the modern ground surface (sample 3); (2) sediment associated with burnt structural timbers collapsed on the base of the pit, generally with some re-deposited sand lenses representing successive infilling episodes on the base of the underfloor cellar, with clean sand substrate beneath (samples 1, 2, 4, 6, 8, 10 and 11); and (3) the burnt vertical edge of the pit to the outside of the timber revetment (sample 5).

Sample	*Ag*	*Al*	*As*	*B*	*Ba*	*Be*	*Bi*	*Ca*	*Cd*	*Co*	*Cr*
Unit	*ppm*	*%*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*	*%*	*ppm*	*ppm*	*ppm*
1	0.2	0.26	20	10	70	<0.5	<2	0.45	<0.5	3	18
2	<0.2	0.18	7	<10	30	<0.5	<2	0.19	<0.5	4	9
3	<0.2	0.2	8	<10	60	<0.5	<2	0.17	<0.5	4	9
4	<0.2	0.24	10	10	50	<0.5	<2	0.72	<0.5	3	12
5	<0.2	0.2	8	<10	70	<0.5	<2	0.19	<0.5	3	8
6	<0.2	0.19	8	<10	50	<0.5	<2	0.31	<0.5	3	9
7	<0.2	0.2	11	<10	30	<0.5	<2	0.22	<0.5	3	9
8	<0.2	0.2	10	<10	30	<0.5	<2	0.18	<0.5	4	9
9	<0.2	0.2	9	<10	50	<0.5	<2	0.34	<0.5	4	9
10	<0.2	0.2	12	<10	30	<0.5	<2	0.21	<0.5	3	10
11	<0.2	0.21	16	<10	40	<0.5	<2	0.29	<0.5	3	14
12	<0.2	0.15	5	<10	10	<0.5	<2	2.89	<0.5	2	5
13	0.2	0.33	9	<10	30	<0.5	<2	0.33	<0.5	4	9
14	<0.2	0.43	4	<10	30	<0.5	<2	0.81	<0.5	4	10
15	0.2	0.35	9	<10	30	<0.5	<2	0.28	<0.5	4	9
16	<0.2	0.33	10	<10	20	<0.5	<2	0.24	<0.5	3	9
17	0.2	0.34	8	<10	20	<0.5	<2	0.26	<0.5	3	9
18	<0.2	0.43	5	<10	30	<0.5	<2	1.01	<0.5	4	10

Sample	*Cu*	*Fe*	*Ga*	*Hg*	*K*	*La*	*Mg*	*Mn*	*Mo*	*Na*	*Ni*
Unit	*ppm*	*%*	*ppm*	*ppm*	*%*	*ppm*	*%*	*ppm*	*ppm*	*%*	*ppm*
1	20	1.24	<10	1	0.11	<10	0.05	548	1	0.02	7
2	9	1.26	<10	1	0.05	<10	0.03	227	1	0.01	8
3	9	1.32	<10	<1	0.06	<10	0.03	546	1	0.01	8
4	10	1.13	<10	<1	0.09	<10	0.04	381	<1	0.02	7
5	10	1.23	<10	<1	0.03	<10	0.02	606	<1	<0.01	8
6	10	1.21	<10	1	0.04	<10	0.03	334	1	0.01	7
7	8	1.17	<10	1	0.04	<10	0.03	275	1	0.01	8
8	7	1.37	<10	<1	0.04	<10	0.03	264	1	0.01	8
9	10	1.34	<10	<1	0.05	<10	0.04	434	<1	0.01	9
10	7	1.22	<10	<1	0.06	<10	0.03	282	<1	0.01	6
11	12	1.45	<10	<1	0.06	<10	0.04	333	1	0.01	10
12	3	0.8	<10	<1	0.03	<10	0.04	103	<1	0.01	4
13	9	1.23	<10	<1	0.03	10	0.04	441	1	<0.01	6
14	6	1.36	<10	<1	0.03	20	0.04	391	1	<0.01	8
15	13	1.25	<10	<1	0.02	10	0.04	420	1	<0.01	6
16	12	1.22	<10	<1	0.02	10	0.03	363	1	<0.01	6
17	5	1.26	<10	<1	0.02	10	0.03	349	<1	<0.01	6
18	11	1.31	<10	<1	0.03	20	0.04	382	<1	0.01	8

Sample	*P*	*Pb*	*S*	*Sb*	*Sc*	*Sr*	*Ti*	*Tl*	*U*	*V*	*W*	*Zn*
Unit	*ppm*	*ppm*	*%*	*ppm*	*ppm*	*ppm*	*%*	*ppm*	*ppm*	*ppm*	*ppm*	*ppm*
1	1230	11	0.01	<2	1	22	0.01	<10	<10	21	<10	62
2	840	9	0.01	<2	1	11	0.01	<10	<10	20	<10	30
3	970	11	<0.01	<2	1	10	0.01	<10	<10	22	<10	52
4	1330	8	0.01	2	1	36	0.01	<10	<10	19	<10	44
5	1060	10	<0.01	2	1	11	0.01	<10	<10	18	<10	54
6	1050	7	0.01	<2	1	16	0.01	<10	<10	18	<10	41
7	940	5	0.01	<2	1	13	<0.01	<10	<10	17	<10	31
8	850	8	<0.01	<2	1	12	0.01	<10	<10	21	<10	30
9	1320	8	<0.01	<2	1	18	0.01	<10	<10	21	<10	42
10	770	8	<0.01	<2	1	12	0.01	<10	<10	20	<10	36
11	1050	9	0.01	<2	1	15	0.01	<10	<10	23	<10	38
12	260	3	0.01	2	1	43	0.01	<10	<10	12	<10	11
13	350	27	0.01	<2	1	9	0.01	<10	<10	22	<10	36
14	280	13	0.01	<2	2	18	0.01	<10	<10	24	<10	25
15	330	24	0.01	<2	1	8	0.01	<10	<10	22	<10	32
16	280	21	0.01	<2	1	7	0.01	<10	<10	21	<10	30
17	270	19	0.01	<2	1	8	0.01	<10	<10	22	<10	26
18	270	13	0.01	2	1	21	0.01	<10	<10	24	<10	28

Ag silver, Al aluminium, As arsenic, B boron, Ba barium, Be beryllium, Bi bismuth, Ca calcium, Cd cadmium, Co cobalt, Cr chromium, Cu copper, Fe iron, Ga gallium, Hg mercury, K potassium, La lanthanum, Mg magnesium, Mn manganese, Mo molybdenum, Na sodium, Ni nickel, P phosphorus, Pb lead, S sulpur, Sb antimony, Sc scandium, Sr strontium, Ti tin, Tl thallium, U uranium, V vanadium, W tungsten, Zn zinc

Table 4.3 The ICP-AES multi-element results from the Farmer's House, with sample numbers 1–11 associated with the micromorphological samples from the same location, and samples 12–18 being control samples of sand substrate

Sample	Context	Fabric	Inclusions
1	761	fine to very fine quartz sand	20% very fine charcoal; one large irregular zone of sand substrate; very few sub-rounded aggregates of dusty clay
2	726	fine to very fine quartz sand	sand grains in upper 2cm have thin discontinuous dusty clay coatings; lower 4cm has 20–25% fine to very fine charcoal and few sesquioxide replaced zones of fine fabric
3	Ground surface	fine to very fine quartz sand	upper 1cm is fire reddened; lower 4.5cm has thin discontinuous coatings of sesquioxide impregnated dusty clay around grains
4	778, 779	fine to very fine quartz sand	upper 1cm is fire reddened; middle 2.5cm is dominated by fine to very fine charcoal with evident horizontal orientation of sand and charcoal; lower 0.5cm is clean sand substrate
5	Basal infill outside (i.e. behind) cellar lining	fine to very fine quartz sand	inner 1.5cm is fire reddened with sand grains partially 'cemented' with sesquioxide impregnated dusty clay in irregular zones; wavy/irregular vertical boundary with middle 4.5cm of porous fine sand with rare fine charcoal inclusions and few dusty clay coatings of grains; outer 1cm is weakly fire reddened
6	900, 860, 808	fine to very fine sand	upper 1cm with abundant very fine charcoal; middle 4cm with evidence of lensing/laminae, inclusion of flint pebbles, few fine charcoal fragments, and irregular zones of sesquioxide impregnated dusty clay coatings grains; lower 1.5cm of clean sand substrate
8	913, 912, 761	fine to very fine quartz sand	upper 2cm with rare fine charcoal and occasional sesquioxide impregnated dusty clay coatings grains; middle 1.5cm as above and slightly reddened; lower 4cm with abundant fine to very fine charcoal, exhibiting lensing; one rare zone of calcium carbonate infill of a void
10	900, 860, 808	fine to very fine quartz sand	upper 4.5cm with abundant fine charcoal with occasional sesquioxide replaced plant tissues, exhibiting lensing/laminae, horizontal to 45 degrees; lower 2.5cm of clean sand substrate
11	900, 860, 808, 652	fine to very fine quartz sand	upper 7cm weakly reddened, with some sesquioxide coatings of grains and few oxidized plant tissue fragments; lower 2.5cm of clean sand substrate

Table 4.4 Summary descriptions of micromorphology samples taken from the Farmer's House

Throughout there are essentially three, slightly different, types of fabrics present: 1) the natural fine to very fine sand substrate, 2) rubified/reddened fine sand as both *in situ* and infill deposits, and 3) infilling fine sand which included fine fragmentary charcoal associated with burnt, collapsed timbers. The latter fabric type can exhibit lensing or laminae in the organisation of the charcoal and fine sand components.

Throughout, the natural sand substrate fabric 1 at West Stow comprises very fine to fine quartz sand (*c*.85–98%) with a loose, porous, single grain structure (Plate 4.2e–f). There is very little organic component except for very rare fragments of oxidised plant tissue remains, and the occasional fine-sand-sized and rounded fragment of charcoal, which is probably the result of soil faunal bioturbated micro-charcoal derived from the pre-fire site environment.

The reddened fabric 2 (Plate 4.2c–d) is similarly dominated by very fine to fine quartz sand (*c*.90%), but contains a minor amount (<10%) of sesquioxide or amorphous iron impregnated silty clay and amorphous organic matter acting as thin, discontinuous coatings of the sand grains and occasionally as very small irregular aggregates of humic silt between the grains, and minor amounts of fine-sand-sized charcoal fragments which exhibit signs of fragmentation caused by oxidation and soil faunal attack. This minor aggregated humic fine fabric between the grains is typical of polymorphic organic matter regularly found in very bioturbated sandy soils and sandy podzols (de Coninck and Righi 1983) such as at Sutton Hoo (French 2005).

Fabric 3 (Plate 4.2a–b) is essentially in association with burnt timbers that have fallen down into the cellar pit. It is similar to fabric 2, but may contain up to about 30% included charcoal. The charcoal ranges in size from substantial pieces with a good cell structure evident (1–3cm) to very fine-sand-size (50–100μm) fragments and silt sized punctuations (<50μm), almost all of which appears to have been subject to the twin deteriorating processes of oxidation and reworking by soil fauna. Both the charcoal fragments and the fine sand fabric may exhibit slight lensing or laminae, from the horizontal to about 45 degrees in orientation (Plate 4.1e).

Group 1: Burnt in situ outer joist

The upper 1.5cm of sand beneath the burnt outer joist was slightly reddened by the heat of the burning timber above (e.g. Plate 4.4e–f). This event is believed to have occurred over less than eight hours burn time of the *c*.20cm thick oak joist. In thin section, it could be seen that the reddening of the sand was a result of the sesquioxide impregnation and heat-induced rubification of the very small amounts of amorphous organic matter and silty clay acting as the fine groundmass on and around the quartz sand grains.

Group 2: Burnt collapsed timbers in the pit

This type of situation revealed a tripartite sequence in most cases comprising the carbonised wood charcoal and calcareous wood ash of the fallen timber floor plank or upright (Plate 4.3), a zone of slightly amorphous iron impregnated fine sand with abundant included fine to very fine charcoal fragments in the pore space, and a fine sand with very minor included organic punctuations, representing either the undisturbed sand or sand infill at the base of the construction pit.

The middle zone of fine quartz sand is dominated by fine charcoal which often exhibits some fine but

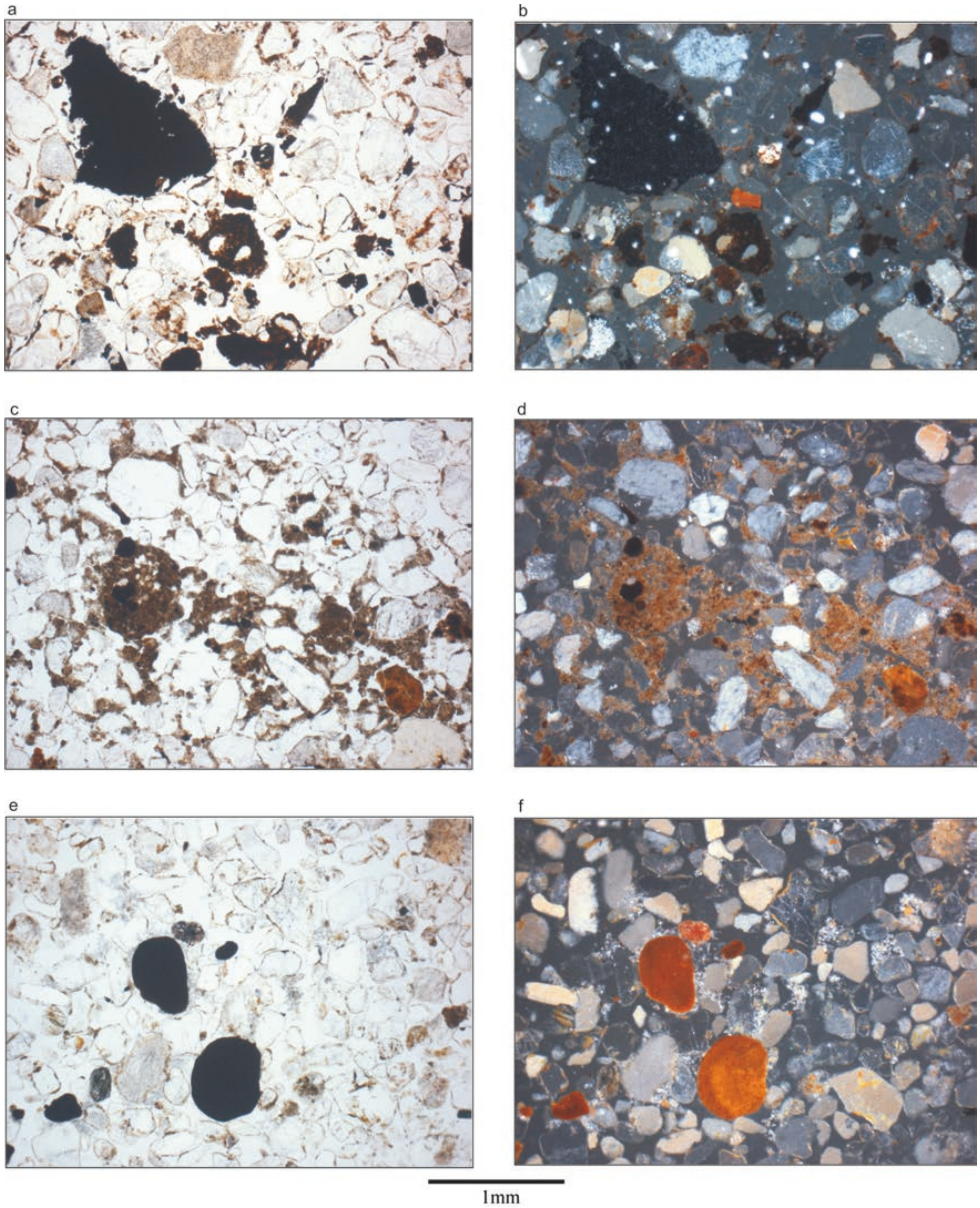


Plate 4.2 The three main fabric types observed in thin section, shown on the left in PPL, and on the right in partial XPL and OIL. These examples are taken from sample 6

(a) Context 808, associated with burnt timbers that had fallen into the pit, containing up to *c*.30% charcoal. The mineral component is dominated by fine sand, with only a minor component of silty clay coating the sand grains. (b) As (a), with the heightened red colour of the iron nodules in OIL showing that they have been rubified by heat. (c) Context 860 contains lenses and aggregates with a higher proportion of silty clay. The dark brown colour of the fine mineral material is due to a combination of organic pigmentation and impregnation by iron. (d) In OIL, the silty clay appears reddish. (e) Context 900, composed predominantly of fine sand with a very minor component of silty clay coating the sand grains. (f) In OIL, relic iron nodules exhibit intense reddish colours due to rubification by heat

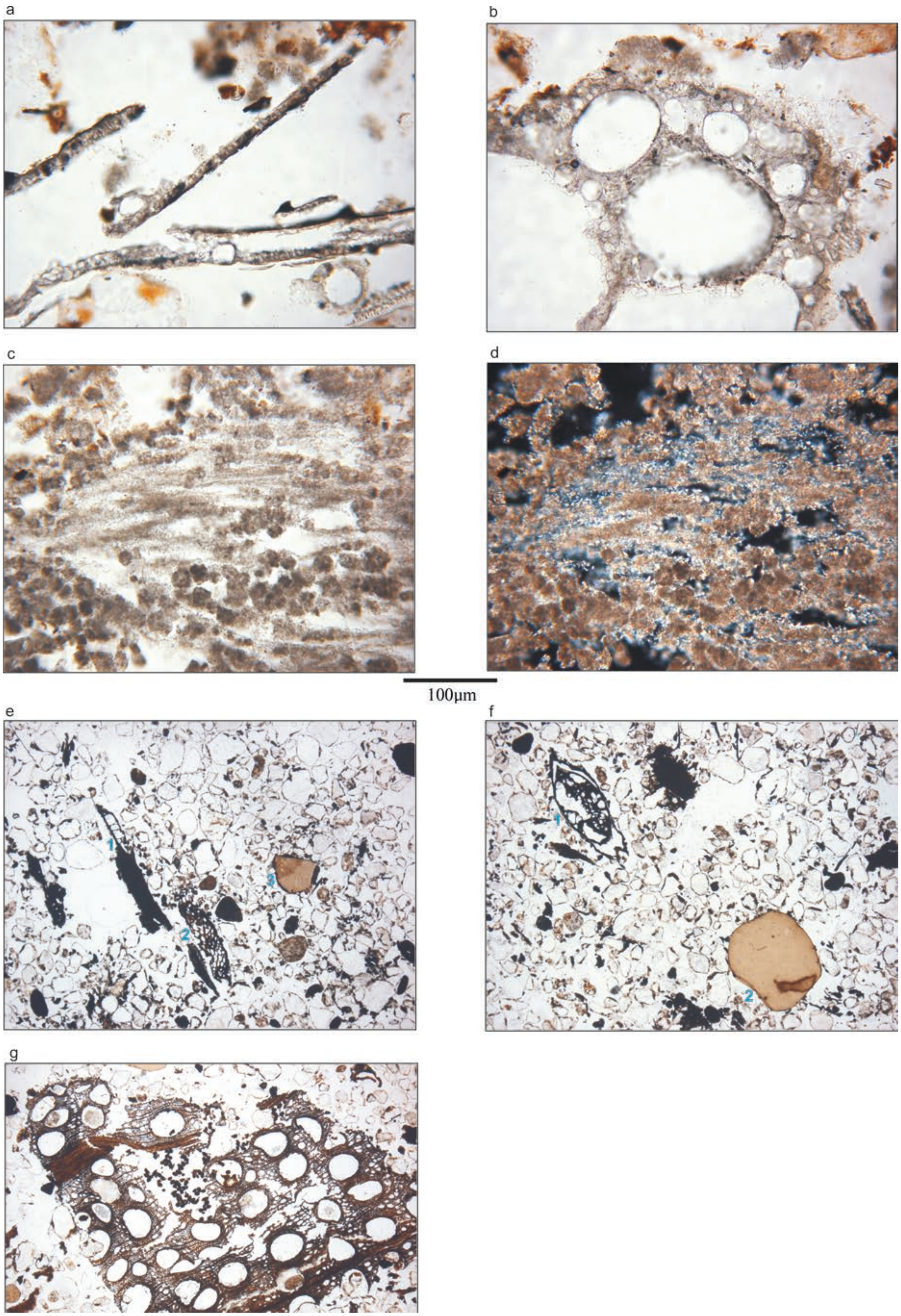


Plate 4.3 The main types of ash and charred botanical materials observed in thin section

(a) Sample 8, context 761, grass ash in the form of phytoliths adhered to by charred plant matter. (b) Sample 8, context 761, non-metallurgical slag. (c) Sample 8, context 761, wood ash in the form of aggregates of fine-grained calcium carbonate. (d) As (c), in XPL. (e) Sample 10, context 808, charred grass (1) and wood (2) tissues, and a grain of chert darkened by heat (3). (f) Sample 10, context 808, charred seed (1) and a grain of chert darkened by heat (2). (g) Sample 10, context 860, charred wood with mite excrement in areas where tissues were only partially charred

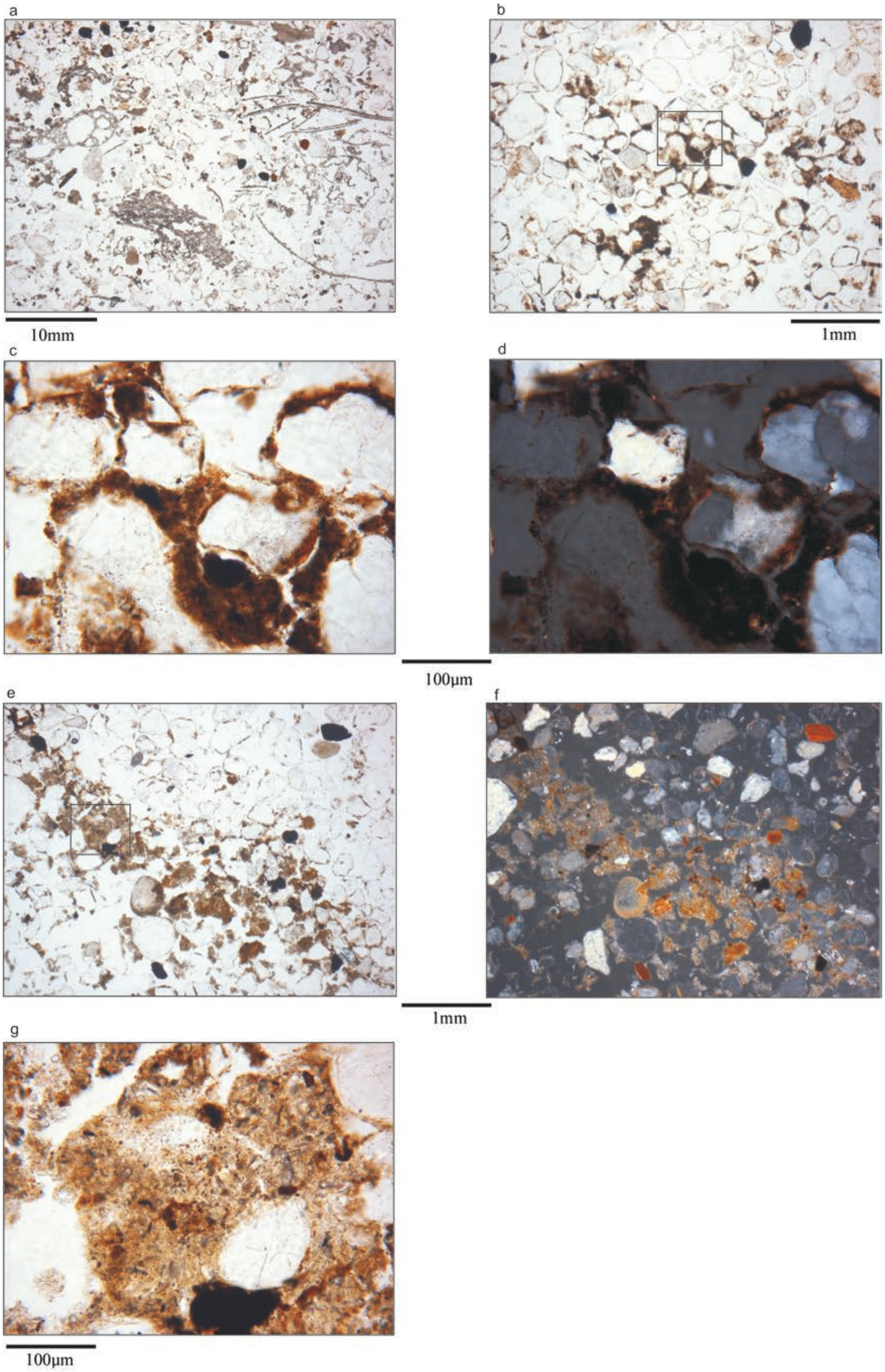


Plate 4.4 The sediment fabric associated with collapse following the burn event (a) contrasted with the fabrics created during the occupation of the building (b–g)

(a) Sample 8, context 761, loose, single-grained microstructure with charcoal and ash, as detailed in Plate 4.4. (b) Sample 8, context 913, more compact, single-grained microstructure with lenses of bridged-grain microstructure where there is more fine mineral material. (c) Detail of fine mineral material in (b). (d) As (c), in partial XPL. (e) Sample 6, context 860, showing another lens of fine mineral material. (f) As (e), in partial XPL and OIL, showing fine mineral material rubified by heat. (g) Detail of (e). Fine mineral material with organic pigmentation, phytoliths and amorphous organic matter discontinuous lensing, seen in both the horizontal and parallel alignment of the quartz grains and charcoal fragment. A first thought was that this probably reflects successive collapse of the wooden structure during the fire and intermittent infilling with sand from the edge of the construction pit as a consequence of the disturbance and exposure during the fire itself. But as there was an interval of about four months between the fire and the excavation of the burnt structure, it is more probable that the alternate lensing of both charcoal and sand represents successive inwashings of fine material into the base of the construction pit in those few months between fire event and excavation.

Group 3: Burnt upright timbers against the edge of the pit
As in the case of the outer joist, the one sample (5) taken from between the timber revetment and the inner vertical edge cut of the pit, revealed a *c*.1.5cm inner zone of reddened fabric. This was similarly caused by amorphous iron impregnation and rubification under hot oxidation conditions of the very minor amorphous organic matter and the minor silty clay fine fraction. Again this is due to the effect of the heat of the burning timber revetment drawing out the soil's iron content to an exposed surface and its oxidation/reprecipitation at the contact surface.

IV. Interpretative results

This section contains a more in-depth description of the primary fills of the cellar of the reconstructed SFB —the sediments that accumulated whilst the building was in use. These results are discussed with respect to the results of other soil studies of Anglo-Saxon SFBs and some experimental data on the effects of wood fires on soils by Canti and Linford (2000).

The impact of the fire
As discussed above, the fire resulted in the reddening of the sandy sediments making up the primary fills of the SFB as well as the natural sandy substrate that surrounded the cut of the cellar pit. This reddening occurred over a thickness of *c*.1.5–2cm, which was comparable to results of burning experiments by Canti and Linford (2000), in which high temperature fires (over 500°C) were found to redden a thin depth of soil if it contained iron-bearing clays. Quartz sand does not itself change colour on burning, and in thin section, it was possible to see that the reddish colour of the layers described in the field as 'burnt sand' was produced by the rubification of iron-bearing silty clay component which coats many of the sand grains (Plate 4.2d) and iron nodules (Plate 4.2f), and the browning of the rare chert grains (Plates 4.3e–f).

In the sandy layers that had slumped down into the pit during and after the collapse of the timber superstructure (contexts 761 and 808), as well as in the sandy layers at the base of the pit (context 900), there was only a minor component of fine mineral material (<5%), and most of the oxidised iron present was in the form of so-called 'relic iron nodules'. These nodules were no longer *in situ* (such nodules usually have diffuse boundaries), but were rounded and smooth-edged pseudosands. Under oblique incident light (OIL), these relic iron nodules exhibited heightened red colours (Plates 4.2b and f), and although it would require sub-microscopic methods to confirm it, this 'rubification' is probably due to the conversion of the iron oxides to haematite under high temperatures (Canti and Linford 2000). The small amount of silty clay in these sediments appeared to have been impregnated with iron. Under the high temperatures of the fire, the iron in the fine mineral material had rubified, contributing the reddish colour to the sands.

In the layers that had accumulated during the use of the structure (contexts 860, 912 and 913, 'Fabric 2'), there was a much larger proportion of fine mineral material (10–15%). Some of this fine mineral material formed thin, discontinuous coatings and bridges between sand grains, but most of it completely surrounds and embeds the sand grains (Plates 4.2c–d and 4.4b–g). The clay component of this fine mineral material has also been impregnated with amorphous iron oxides, and has been rubified by the heat of the fire, thus producing the reddish colours that were visible in the field. These primary occupation deposits exhibited the most vivid reddish colours in the field because they contained slightly more iron-bearing clay than the underlying sands and the overlying collapse deposits.

Contexts 761 and 808, which had been described in the field as 'burnt sand' that was from 'the highest level of accumulation during use', were significantly different from the underlying primary occupation deposits. In addition to containing significantly less fine mineral material, as discussed above, they contained significantly more charred organic matter (up to *c*.30%) (Plates 4.2a and 4.3e–g), as well as ash residues (Plates 4.3a–d), and were often characterised by bedding angles of around 45° (Plates 4.1c and e). These bedding angles strongly suggest that the material accumulated as a result of the collapse of the superstructure into the cellar pit during the fire, or slumping or inwashing from the edges of the pit during the four months between the fire and the excavation, during which time the pit was exposed to weathering. If these layers were indeed from the highest level of accumulation during the use of the building, they were substantially disturbed during the collapse of the superstructure.

It is also notable that there is visible stratigraphy in the charred organic component and the ash residues. Contexts 761 and 808 did not only contain charred wood fragments, but also charred grasses, charred seeds, and grass ash residues, all of which probably derived from the thatched roof (Plates 4.3a–b, e–f and 4.4a). In contrast, the charred component of the occupation deposits 860, 912, and 913 was restricted to charred wood, probably from the collapse of the floor timbers.

It is also possible to interpret differences in the temperature and/or oxidation conditions of the fire. Burning and ceramic firing experiments have shown that reddening of iron oxides and iron-bearing clays requires temperatures of *c*.500°C or more (Canti and Linford 2000). In Sample 8, context 761 contained significant quantities of wood ash in the form of aggregates of very fine-grained calcium carbonate (Plates 4.3c–d), ash that can only have been produced if the wood was burnt in oxidising conditions at temperatures higher than *c*.500°C. Closely associated with the wood ash in Sample 8 was grass ash and significant quantities of vesicular, non-metallurgical slag (Plate 4.3b). Sometimes also called 'vitrified ash', non-metallurgical slag can form in fires where there is a sufficiently high temperature to melt silica (Evans and Tylecote 1967). The vitrification of silicate sands and phytoliths normally requires temperatures close to 1000ºC, but in the presence of fluxing agents such as potassium, which is abundant in wood ash, the fusion of the siliceous material could have occurred at temperatures of *c*.800°C and possibly even lower (McDonnell 2001). The presence of non-metallurgical slag and other ash residues in 761 may be due to the greater aeration of the sediments and the higher temperature of the fire there than lower down in the stratigraphy.

There was surprisingly little wood ash associated with the burnt building when it was excavated. In addition to the majority of the ash blowing away in the strong wind on the night of the fire (see Chapter 3), it is likely that at least some of the wood ash was dissolved by the acidity of percolating rain water during the four months between the fire and the excavation (see also Chapter 5).

The primary fill

As has already been noted, the primary fill of the cellar of the burnt building, which was represented by contexts 860, 912, 913, and possibly also 900 (although the latter may be more associated with the initial construction of the house), differed significantly from the overlying collapse deposit, 761/808. One of the differences between these sediments was their composition: while the upper collapse deposit contained ash residues and charred grasses (as phytoliths) as well as charred wood, the primary fill contained only charred wood fragments, without any evidence for burnt thatch. The collapse deposit and the primary fill also differed in their compaction, with the sand in the lower, primary fill being notably more compacted than the upper fill (compare Plates 4.4a and b). Finally, the collapse deposit and the primary fill differed in the quantity and organisation of the fine mineral material. Silty clay was much more abundant in the primary fill, where it was concentrated in thin horizontal lenses. These lenses were particularly distinct in Sample 8, where there was a sequence of many fine horizontal lenses, and in Sample 6, where the lenses were thicker and often associated with horizontal or sub-horizontal planar voids (Plates 4.1b and e).

A close examination of the silty clay material embedding the sand grains shows that it was probably derived from the local A horizon, or topsoil. For example, the silty clay of the fine groundmass was stained brown by humic acids, and was intimately mixed with amorphous, fully decomposed organic matter and disarticulated phytoliths (Plates 4.2c and 4.4b–g). The fact that these sand, silt, and clay lenses were derived from the local topsoil, together with their horizontal orientation and their successive layering, suggests they were created by trampling. The most likely scenario is that when the re-enactors or other visitors (e.g. Milner 2003), entered the cellar, they carried small aggregates of topsoil that were adhering to their shoes, which then smeared or became dislodged on the sandy floor surface.

The evidence for trampling in the primary fill of the reconstructed Farmer's House cellar differs significantly from the micromorphological characteristics of the fills of excavated Anglo-Saxon SFBs. At Bloodmoor Hill, Carlton Colville, Suffolk (Milek 2009), Bourn Bridge, Cambridgeshire (French 1996), Sherbourne House, Lechlade, Gloucestershire (Heathcote 1999), Harrold, Bedfordshire (Macphail 2000), Oakly Road, Clapham, Bedfordshire (Macphail and Crowther 2004), Stratton, Bedfordshire (Macphail and Cruise 1998) and many of the *Grubenhäuser* excavated at West Heslerton, North Yorkshire (Macphail 1998; Macphail *et al*. 2006) and Tempsford Park, Tempsford, Bedfordshire (Macphail and Cruise 1996) the fills of the SFBs were remarkably homogeneous, with no visible horizons or identifiable primary fills that could be associated with the original occupation of the buildings. At Bloodmoor Hill, the clayey 'crusts' that were observed at the base of the sunken features in the field, and which were interpreted as possible floor surfaces, were found in thin section to be post-depositionally formed iron-clay bands, dominated by illuvial clay (Milek 2009). The horizons in the fills of the SFBs at Sherbourne House, which were visible in the field, could not be distinguished in thin section (Heathcote 1999). Even at Bourn Bridge, where there was a clay hearth at the NW end of one *Grubenhaus*, and there should have been an associated floor deposit, the fills were homogeneous (French 1996). These homogeneous fills were interpreted as the result of soil or turf deposition, often (but not always) incorporating small amounts of fine midden debris, which often shows signs of reworking by soil fauna. They were thought to relate either to the rapid and intentional infilling of the sunken features with local soils (which might be more or less contaminated with occupation debris from the settlement), or from the collapse of turf building materials used in the construction of the original buildings. In their survey of Anglo-Saxon *Grubenhäuser*, Macphail *et al*. (2006) and Goldberg and Macphail (2006, 241–244) note that *Grubenhäuser* fills that can be characterised as heterogeneous, such as some of those at West Heslerton, Yorkshire (Macphail 1998) relate to secondary use of the pit, especially for post-abandonment dumping, rather than to the primary occupation of the buildings.

The slight evidence for a trampled floor surface in the cellar of the Farmer's House at West Stow, as occurs in some archaeological examples of Anglo-Saxon SFBs (Macphail *et al*. 2006), may be attributed to the unique circumstances associated with the use and post-use life of this reconstruction: the use of the cellar by re-enactors, the destruction of the building by fire, and the excavation of the house within months of its collapse, without any intentional or gradual/natural infilling with turf building materials or the surrounding soils. In contrast to excavated Anglo-Saxon SFBs, the Farmer's House cellar revealed the accumulation of floor deposits of *c*.10–15cm. These were composed of a lower *c*.10cm of yellowish-brown sand (unburnt) with discrete patches of darker brown and slightly compacted sand above (see Chapter 3). On this surface were slight linear ridges of sand, and also against the sides of the cellar, with artefacts accumulating in and on these deposits. In common with Anglo-Saxon SFBs which exhibit heterogeneous fills related to dumping of settlement-derived midden material and evidence of site activities, the excavation of the Farmer's House recovered many hundreds of artefacts from the cellar, which were related to its relatively short use life, including pottery, pencils, pencil lead and coins that had been dropped by re-enactors and visitors (see Chapter 3).

As pointed out by Heathcote (1999), the sides of the pits of many Anglo-Saxon SFBs were steep and showed little sign of long-term exposure or weathering. The most logical explanation for this is that they were rapidly infilled, either by the natural or intentional collapse of a turf superstructure, or by intentional infilling using the surrounding soils on the settlement. It was also suggested by Milek (2009) that the edges and base of the sunken features could have been lined with timber, a practice that would have helped to maintain the steep vertical faces of the pits and would have effectively prevented the accumulation of primary fills. The timber panels used for the lining could have been either removed when the buildings were abandoned, or left to decompose *in situ*. Once the Farmer's House building had been destroyed by fire and was left exposed to the elements for about four months prior to its excavation, large blocks of sand from the unconsolidated and unlined cellar sides had quickly collapsed onto the cellar floor.

In addition, post-depositional bioturbation by soil fauna, which would naturally have been attracted to the higher organic content of the SFB fills relative to the surrounding sandy subsoils, was a strong contributor to their homogeneity. However, a recent micromorphological study of sandy, severely bioturbated early medieval floor deposits, which were difficult to identify in the field, found that small fragments of trampled floors can survive severe bioturbation (Milek and French 2006). It seems unlikely that in all Anglo-Saxon SFBs studied using soil micromorphology, bioturbation could have completely reworked the primary deposits of these buildings, although it is possible that primary deposits that were not trampled floors, but loose material that had filtered through floorboards, could be difficult or impossible to identify following severe reworking by soil fauna. In his geoarchaeological study of the fills of nine *Grubenhäuser* at West Heslerton, in North Yorkshire, Macphail (1998; Macphail *et al*. forthcoming) observed that it was sometimes possible to distinguish primary from secondary fills on the basis of differences in composition. While the primary fills of the *Grubenhäuser* in Areas 2A and 12AA contained inclusions such as calcareous daub and organic debris, which Macphail (1998; Macphail *et al*. forthcoming) related to the original construction and/or initial use of the structures, the upper fills contained a wider range of waste materials, including cereal processing waste, hearth waste, and coprolites. All of the fills had been severely reworked by soil faunal activity, however, and Macphail did not identify trampled floor surfaces. In addition, it remains possible that the construction materials identified in the primary fills do not date to the initial construction of the buildings, but to their abandonment; for example thatching materials and aggregates of dried/burnt daub could have fallen into the base of the sunken feature if the buildings were dismantled to salvage the timber. In Area 2DA and Site 11 at West Heslerton, it was not possible to distinguish between primary and secondary fills, and Macphail (1998; Macphail *et al*. forthcoming) suggested that they had been rapidly infilled with blown sand and waste materials from iron-working and cereal production.

V. Conclusions

The destruction of the Farmer's House resulted in the reddening of the *in situ* sand over a thickness of 1.5–2cm. This phenomenon was particularly evident where there was contact with large burnt timbers. This accords well with the experimental observations of soil burning made at the Eton Rowing Lake on a sand/gravel terrace in Oxfordshire by Canti and Linford (2000) where a high temperature burn of 550°C or greater over a 24-hour period was required to redden the upper few centimetres of soil.

The West Stow fire was a very fast and probably very high temperature burn over several hours, aided by dry timbers and thatch, and a strong wind that night (see Chapter 6). This resulted in a very clean burn with much of the superstructure destroyed and little or any wood ash remaining *in situ*. The very minor component of wood ash present in thin section in the fine fraction of the sand in the cellar pit, except very minor amounts in a few pore spaces, is remarkable.

The other main effect of the fire that is evident both in thin section and in the field was the inclusion of abundant fine charcoal (see also Chapter 5). But, even in the few months since the event, the charcoal fraction has begun to suffer from oxidation and soil faunal attack leading to its fragmentation and its dispersal down-profile (i.e. over at least 10cm).

After the fire the cellar pit of the building was exposed. The unconsolidated sand began to collapse into the cellar and fine charcoal became inwashed into the cellar. This was represented by a series of fine, alternating lenses over a thickness of *c*.2–4mm, which took at most four months to form. This laminar aspect has almost been destroyed by subsequent bioturbation.

The geochemical tests done for comparison with the thin section micromorphology from the Farmer's House were, on the whole, disappointing. In a few instances, the burnt surface showed good correlation with enhanced magnetic susceptibility results, perhaps reflecting the strong presence of manganese in all archaeological and control samples. There were sometimes also higher barium and calcium contents, which may be associated with the presence of wood ash, but there were by no means any clear geochemical signatures of the fire. Phosphorus values were also weakly enhanced in the fill deposits as compared to the modern background control samples, probably reflecting the 'debris of living' to a limited extent. Having said that, one can only stress how difficult it is to take small bulk samples from a section in the field to the degree of micro-stratigraphical precision that is necessary to relate them directly to horizons and lenses seen in thin section. Nonetheless, an earlier study of the phosphate enhancement and carbon loss of the cellar floor completed by Milner (2003) did show use differences with greater carbon and phosphate around/beneath the hearth area and in a linear zone from the doorway to the hearth. Moreover, several instances of multiple geochemical, magnetic susceptibility and micromorphological analyses of SFB fills have been very successful in identifying both site activities and infilling processes (e.g. Macphail *et al*. 2006).

Nonetheless, without the previous studies of Milner (2003) and meticulous excavation under known circumstances of the Farmer's House, one could easily have drawn different conclusions from the soil analyses undertaken. Indeed, the presence of much fine charcoal in the groundmass, a slightly reddened matrix, small quantities of wood ash and higher magnetic susceptibility values could have easily led to the conclusion of a 'close to a hearth' type of context. Despite the intensity of the conflagration, minimal signatures of an *in situ* house fire remained in the soil data. This is a rather salutary lesson.

In conclusion, the primary fill of the cellar of the burnt Farmer's House at West Stow exhibited several of the features observed in many excavated examples characterised by homogeneous fill types. But the evidence of use in life was slight, and post-depositional infilling processes were very important in the transformation of the original soil record. In comparison with excavated examples of Anglo-Saxon SFBs, there are two possible reasons for this. First the base of the SFBs had generally been protected by timber floorboards, either on the base of the pit itself, or at some distance above it, which prevented the accumulation of sediment during their use. Secondly the rapid infilling of the pits with topsoil and variable quantities of organic-rich waste products from the surrounding settlement promoted bioturbation, and this bioturbation was so severe that the original composition and structure of the primary deposits became completely reworked. In particular, it remains likely that any material filtering down through raised floorboards, which would have been fine-grained, loose, and possibly of insignificant depth, could have been rapidly incorporated into the secondary fills by bioturbation.

Directions for future work

Based on the results of this geoarchaeological study, there is good potential to gain valuable reference samples from the other (unburned) reconstructed SFB at West Stow. For example, it would be extremely beneficial if two types of reconstructed buildings — one with raised timber floors, where the underlying cavity was protected and undisturbed, and one where the active floor surface was at the base of the pit — could be sampled using the same methods recommended for archaeological houses. Normally, the recommended sampling strategies would include bulk sampling of the primary fills/floors on a systematic 50cm grid for geochemical, macro-organic and magnetic analyses (both within the pits and outside of them, in the natural subsoils), in order to determine if the sediment contained any evidence for the activities that took place in the structure and the spatial organisation of these (e.g. Milek and French 2006). It would also include systematic micromorphological sampling along one or two transects (both within the pits and outside of them, in the natural subsoils), in order to observe the degree of sorting, the composition, internal bedding (if present) and the microstructure of the primary fills. By studying the primary fills of the experimental reconstructions using this suite of techniques, useful sets of reference samples could be obtained with which to interpret the construction methods and use of space in any Anglo-Saxon SFB excavated in the future, complementing research already conducted by Tipper (2000; 2004) and Macphail (e.g. Macphail *et al.* 2006). As micromorphological studies of archaeological SFBs have often found it difficult to distinguish primary fills or floor deposits, even where the archaeological evidence had suggested that they should be present (e.g. French 1996; Heathcote 1999), it would be useful to extend the experiment to include the investigation of post-depositional site formation processes. These sets of information could be used to advise on the most effective geoarchaeological sampling strategies of SFBs in the future.

5. Insect and Plant Remains

by Gill Campbell and Harry Kenward

I. Introduction

One of the aims of undertaking the archaeological investigation of the burnt Farmer's House was to investigate the survival and taphonomy of plant and insect remains contained in, and forming the fabric of, the building as well as the environment in which it stood. The work has benefited from the fact that the components of the building, such as the type and nature of the thatch and timber used in its construction, were recorded in detail, as were the building's contents. In addition, a vegetation survey of the immediate area of the burnt remains following the fire meant that the results from the study of the plant remains could be compared with the vegetation that survived the fire or germinated from the soil seed bank. The results from the vegetation survey are discussed by Rachel Ballantyne in the final section of this chapter. Similarly, a series of pitfall traps were placed in the four other reconstructed buildings to sample the live insect population and thus provide a comparison with the results from the burnt building. The results from these pitfall traps were published separately (Kenward and Tipper 2008).

The study of the plant and insect remains from the burnt SFB had the following specific objectives:

- To establish what part of the plant materials used in the building or forming the building contents survived as recognisable a) charred plant remains b) uncharred remains.
- To establish whether the vegetation that grew around the building and/or the soil seed bank survived as recognisable a) charred plant remains b) uncharred remains.
- To determine to what extent the dead remains of insects present before burning survived, and whether living insects within the burnt building were killed (and thus formed a death assemblage), were charred, or escaped from the building and what environments were represented by these remains.

In order to achieve these objectives, small samples were taken from different points around the central cellar pit. Flotation samples were also taken as part of the excavation of the cellar pit. Known parts of the building, e.g. unburnt remains of thatch, were also sampled for comparative purposes.

II. Methodology

(Fig. 5.1 and Table 5.1)

As outlined above, small samples of up to 1 litre were taken from different points on the surface around the central cellar pit and recorded in three dimensions. Particular attention was paid to any remains of burnt thatch. Some samples were also taken from underneath burnt wall planks and other timbers for comparison with these surface samples. This resulted in a total of 18 specialist samples with four samples taken from areas identified as thatch in the field. In addition, samples were taken of a patch of unburnt thatch, part of the trapdoor to the cellar and the remains of a spar. Four samples of twine were also recovered. This resulted in a total of 25 specialist samples.

Each layer encountered during the excavation of both the SW and NE quadrants was sampled. A single flotation sample was also taken from the NW quadrant. Many of the layers encountered during the excavation of the quadrants were very thin and could not be seen in section and for these layers a sample of 10 litres was all that was practical to take. Other samples were of 20 litres. In total, 12 samples were taken from the SW quadrant and nine from the NE quadrant.

Each of the flotation samples was processed in a modified Siraf tank with a 250 micron mesh used for the flot (the material which floats) and a 500 micron mesh used for the residue (the material that does not float). The resulting flots and residues were air dried. The specialist samples were dry-sieved down to a mesh size of 250 microns. Both types of sample were then assessed briefly as to their contents using a binocular dissecting microscope at magnifications up to x50.

It rapidly became clear that the samples were very rich in both charred and uncharred plant remains and insects and that sub-sampling would be required in order reduce the amount of material to be studied. Although the preservation and survival of wood, other plant remains, and insects varied across different samples, overall the assemblages tended to contain the same type of remains. Therefore, it was decided that the full analysis of all the samples was not necessary to meet the aims and objectives of the project and that analysis would concentrate on surface samples around the S side of the building and on the flotation samples obtained during the excavation of the NE quadrant.

Thus eight of the nine flotation samples from the NE quadrant were chosen for analysis along with a single sample from the collapsed side of the pit (context 374) in the SW quadrant. The sample from context 648 from the NE quadrant was not investigated further as it appeared very similar to that from context 651; 648 was possibly a continuation of layer 651.

Four surface samples from the S side of the building were also chosen for detailed study: 73, 76, 85, and 107. Their positions are marked on Fig. 5.1. Sample 76 was identified as thatch in the field and was taken from underneath a collapsed wall board. The other surface samples analysed were not protected from the elements and consisted of a mixture of charcoal, ash, thatch and burnt sand. Further details concerning the samples analysed are given in Table 5.1.

Each sample was sorted for both charred and uncharred insect and plant remains, including wood. All the remains >4mm and remains between 4mm and 2mm were sorted into broad categories (oak charcoal, cereal straw) and quantified and weighed as a way of looking at

Figure 5.1 (a) The percentage occurrence of broad categories of different plant remains in specialist samples based on fragment counts: >4mm fraction

Figure 5.1 (b) The percentage occurrence of broad categories of different plant remains in specialist samples based on fragment counts: 4–2mm fraction

Context/ Sample number	Quadrant of cellar pit	Formed when?	Insects present	Quantity (litres)	Description
73	Outside pit	Fire	Y	1	Thatch ash and charcoal from S side of the remains *c.*1.50m beyond the wall line on the ground surface, to the W of the doorway
76	Outside pit	Fire	Y	1	Thatch ash and charcoal from SW corner of the remains preserved below a collapsed wall plank from the S wall, *c.*1.40m beyond the wall line on the ground surface. The thatch ash showed a much higher level of preservation where it had been protected from the elements
85	Outside pit	Fire	Y	1	Thatch ash and charcoal from SE corner of the remains, *c.*0.75m beyond the wall line on the ground surface
107	Outside pit	Fire	Y	1	Thatch ash, charcoal and burnt sand from (S) W side of the remains, *c.*1.50m beyond the wall line on the ground surface
374	SW	Fire/Post-fire	Y	20	Side collapse in SW quadrant
423	NE	Fire/Post-fire	Y	20	Mixed collapsed orange and yellow burnt sand layer (containing charcoal fragments) in NE quadrant. The uppermost layer of collapse in the NE quadrant, and the result of erosion and side collapse between the fire and excavation. Overlies 603
600	NE	Fire/Post-fire	Y	10	Dark brown (burnt) sand layer below 423 and above 603 collapse, NE quadrant. Not visible in section
603	NE	Fire	Y	20	Brown, and largely unburnt, sand underneath 600 in NE quadrant. Above the collapsed cellar lining and appears to have collapsed in from behind/outside the cellar lining (i.e. backfill around the original lined cellar)
651	NE	Fire	Y	10	Mixed orange and black burnt sand, and also grey ash, layer in NE quadrant
726	NE	Fire	Y	10	Dark brown and black burnt sand under collapsed (second lowest) board of cellar lining along the N side of pit in NE quadrant
761	NE	Use accumulation	Y	10	Thin dark brown burnt sand layer, *c.*0.01m thick, with patches of black sand overlying it, across the base of cellar pit in NE quadrant. Appears to be remains of highest accumulation deposit below the suspended floor
767	NE	Fire	Y	10	Layer of grey sand and ash with moderate charcoal fragments. It surrounds and extends below charred (collapsed) floor planks on E side of NE quadrant. Probably collapse rather than accumulation deposit
912	NE	Use accumulation	N	10	Reddened burnt sand layer across the base of the cellar pit in NE quadrant, directly below 761. Apparently accumulation deposit below the suspended floor

Table 5.1 List of the samples analysed from the Farmer's House remains, with contextual information

the variation between samples. Below 2mm the remains were not weighed and quantification of charcoal, wood and cereal straw, etc., was not attempted. However, full quantification was undertaken on seeds and rachis fragments as is standard archaeobotanical practice.

Identification of plant remains was carried out by Gill Campbell with reference to the modern comparative botanical reference collection at English Heritage, Portsmouth. The results are presented in Table 5.2. Nomenclature follows Stace (1997) for wild plants and Zohary and Hopf (2000, table 3, table 5) for the cereals.

Identification of the insect remains was carried out by Harry Kenward using the reference collections held in the Department of Archaeology, University of York and standard reference works including reliable web resources. Adult beetles and bugs were recorded fully quantitatively, other remains on a semi-quantitative scale (counts for 1–3 individuals, 'several' for an estimate of 4–9, 'many' for 10 or more, and an order of magnitude for vary large numbers, see Kenward 1992). The results are presented in Table 5.3. Nomenclature follows Kloet and Hincks 1964–77.

III. Results

(Plates 5.1–5.4 and Tables 5.2–5.4)

The sample of undamaged thatch from the roof of the Farmer's House is made up of clean bread wheat straw (Plate 5.1). There are no remains of weeds within this straw as can be the case in medieval thatch (Moulins 2006).

Oak (*Quercus* sp.) charcoal was recovered from all the samples and is the principle component in some samples (107 and context 767). The frequency of unburnt wood and bark is greatest in the upper layers of the central pit. It largely mirrors that of the oak charcoal. Insect damage is evident in many of the oak charcoal fragments and frass (the excrement of plant eating insects) is recorded both charred and uncharred in the flotation samples (Plate 5.2). Uncharred frass broke up easily on sorting and is likely to be under represented. The fragments of charred frass are also very delicate but seem to be associated with samples producing lots of burnt oak charcoal. Small amounts of very well preserved or 'fresh looking' non-oak charcoal are also occasional finds within the samples. Some fragments appeared worked or are from small diameter

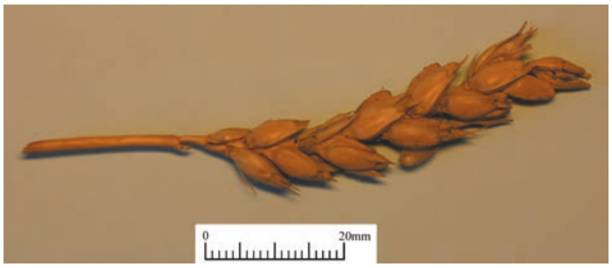


Plate 5.1 Ear of uncharred bread wheat (*Triticum aestivum*), retrieved from some undamaged thatch from the collapsed roof of the Farmer's House

roundwood and are derived from a number of different types of wood. They are discussed in more detail below.

Charcoal that appears less 'fresh' than the very well preserved oak charcoal and the small amounts of non-oak charcoal is present in three of the four surface samples studied, and in some of the flotation samples, especially context 374. This less fresh looking charcoal is characterised by one or more of the following attributes: silt adhering to the surface, rounded edges, a silvery appearance when compared to the 'fresh' charcoal at low power magnification (up to x20). It seems likely that this charcoal is derived from earlier events than the fire that destroyed the building and as such it has been termed ancient charcoal in Table 5.2. The possible origin of this 'ancient' charcoal is discussed below.

Cereal remains, either uncharred, preserved by charring or reduced to silica, are present in all the samples and are the most numerous items recovered other than charcoal and wood. This is not surprising given that the roof of the building was thatched with bread wheat straw and that one of the objectives of the sampling strategy was to target this material. However, very few cereal remains were recovered from the upper fills of the NE quadrant (contexts 423, 600 and 603) and from the base of the pit in the NE quadrant (context 912). Some samples contain fragments of fused sand and ash, with plant parts still recognisable within the fragments. This has been recorded as fused plant ash and seems to be largely composed of cereal remains reduced to silica, sand and fuel ash slag. A solid lump of this material was recovered as sample 71 (Plate 5.3). Fused plant ash is a particular feature of the specialist surface samples (Fig. 5.1) but also of some of the layers forming in the cellar pit, notably 374, 600 and 651.

The other plant remains that are plentiful as both charred and uncharred remains in the samples are the flowering and fruiting parts of trees, especially pine (*Pinus* sp) and birch (*Betula* sp.). Leaves of saw sedge (*Cladium mariscus*) are also frequent in the samples.

Seeds of stinging nettle (*Urtica dioica*), white campion (*Silene latifolia*), probable fat hen (*Chenopodium* cf.*album*) sheep's sorrel (*Rumex acetosella*), small seeded legumes (Fabaceae indet.), bur chervil (*Anthriscus caucalis*), ground ivy (*Glechoma hederacea*), sedge (*Carex* spp.) and small seeded grasses (Poaceae indet.) are also common finds. These plants all grow within the vicinity of the Farmer's House (Plate 5.4; Ballantyne, this chapter).

In the samples, some of these taxa are more numerous as charred remains (e.g. small seeded grasses and saw sedge leaves) while others are present in small numbers as charred macrofossils remains but plentiful as uncharred remains (e.g. fat hen and sheep's sorrel). The following taxa that could be identified beyond family level are only present as uncharred remains:

Arenaria serpyllifolia	thyme leaved sandwort
Rubus section *Glandulosus*	blackberry
Myosotis sp.	forget-me-not
Atriplex sp.	orache
Claytonia perfoliata	spring beauty
cf. *Salix* sp. bud	willow bud
Carduus sp. and *Carduus /Cirsium* sp.	thistle

The following taxa that could be identified beyond family level are only present as charred remains:

Ranunculus section *Ranunculus*	buttercup
Papaver dubium/ rhoeas/ hybridum	poppy
Stellaria graminea	lesser stitchwort
Scleranthus cf. *annuus* *	annual knawel
Fallopia convolvulus	black bindweed
Epilobium sp.	willowherb
Pistachia vera	pistachio nutshell
Plantago cf. *media*	hoary plantain
Euphrasia/ Odontites sp.*	eyebright/ red bartsia
Poa annua type	annual meadow-grass type
Hordeum sp. grain*	barley grain
Avena type awn *	oat type awn

* Specimens appear worn in the same manner as some of the charcoal fragments

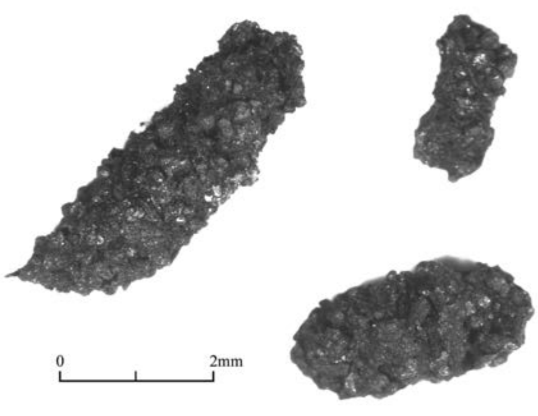


Plate 5.2 Charred frass from context 761

Plate 5.3 A lump of fused plant ash (sample 73)

Two contexts, 603 and 912, contain mineral-replaced plant remains in trace amounts.

Substantial numbers of insects were recovered from the samples, both charred and uncharred, and also toasted (see discussion of preservation). Many of the identifications were straightforward, either because the remains are in excellent condition or because they are so damaged that it would by unwise to attempt close identification. Some specimens are in good condition but lacked diagnostic characters.

All of the remains of *Anobium* species are assumed to be *A. punctatum*, which is abundant in the buildings at West Stow. *Euophryum* weevils are all recorded as *E. confine*, but distinction from *E. rufum* (Broun) is very difficult in this type of material.

Insects are present in all four specialist samples analysed but only in small numbers. 73, 76 and 85 contain predominately charred remains, 107 mostly uncharred. The total MNI of charred beetles and bugs from these contexts is seven. The identifiable taxa are a mixture of mould feeders and 'outdoor' forms. The uncharred insects include only four beetles, all from outdoor habitats (two ground beetles, a ladybird and a ground-living weevil).

Insect remains were obtained from all of the flotation samples analysed from the NE quadrant, with the exception of the sample from context 912. The samples from context 374 also produced insect remains.

In contexts 374, 423, 603 and 767 uncharred remains predominate while in contexts 651, 726 and 761 charred insects predominate. Context 600 appears to be dominated by toasted insects. The uncharred and toasted insect remains comprise mainly beetles, principally outdoor species with only a few beetles categorised as house fauna or likely to have facultatively occupied habitats within a building.

Allowing for variations in assemblage size the uncharred groups can be regarded as essentially similar, with a few 'other orders' (i.e. not beetles or bugs), and assemblages of beetles dominated by outdoor forms and with only a few beetles categorised as house fauna or likely to have facultatively occupied habitats within a building. There are ground beetles (*Calathus* species and *Syntomium ?truncatellus*), various generalist decomposers (e.g. *Megasternum obscurum*, *Cercyon analis*, *Anotylus complanatus* and *Gyrohypnus angustatus*), ground living weevils (*Otiorhynchus ovatus*, *Philopedon plagiatus*), and plant feeders (*Simplocaria semistriata*, *Subcoccinella vigintiquatuorpunctata*, *Crepidodera* sp., *Sitona lineatus*, *Ceutorhynchus* sp, *?Gymnetron* sp.). Some dung beetles (*Aphodius* and *Onthophagus* sp.) are also present. A few taxa almost certainly originated within the building: the woodworm beetle *Anobium punctatum*, the wood-boring weevil *Euophryum confine*, and *Stegobium paniceum*. Charred remains of beetles likely to have lived in the structure include *Laemostenus terricola*, *Anobium punctatum*, and *Euophryum confine*.

The assemblage of apparently 'toasted' insects — from context 600 — is again dominated by outdoor beetles (*Oulema melanopa*, *Chaetocnema arida* group, *?Coeliodes* sp. and *Cidnorhinus quadrimaculatus*). There are some beetles which probably originated in the structure, namely *Mycetaea hirta* and *Euophryum confine*. The few charred insects included plant-feeding bugs such as the cuckoo-spit froghopper *Philaenus spumarius* and the nettlebug *Heterogaster urticae*, and some 'outdoor' beetles, as well as two *Euophryum confine*.

Viewed subjectively the charred insect remains (Table 5.4) differ little from the uncharred and toasted ones.

Plate 5.4 Bur chervil (*Anthriscus caucalis*) and elder (*Sambucus nigra*) growing in view of the replacement Farmer's House (June 2010)

sample/ context number	*73*	*76*	*85*	*107*	*374*	*423*	*600*	*603*	*651*	*726*	*761*	*767*	*912*
sample size in litres	*0.5*	*0.5*	*0.25*	*0.25*	*20*	*20*	*10*	*20*	*10*	*10*	*10*	*10*	*10*
percentage of sample analysed	*100%*	*100%*	*100%*	*100%*	*100%*	*25%*	*100%*	*100%*	*25%*	*25%*	*100%*	*100%*	*100%*
Pinus sp(p.) charcoal	+		+			+**2**		+**4**			++**2**		
Abies/ Cedrus sp. charcoal											+		
Quercus sp. charcoal	++++	++	++++	+++++	+++++	++++	+++	++++	+++++	+++++	++++	+++++	++
Prunus sp. charcoal											+		
Pomoideae type charcoal								+			++		
Betula sp. charcoal											+		
Corylus sp. charcoal - roundwood	+		+										
Alnus sp. charcoal								+					
Fraxinus sp. charcoal		+**1**								++			
Salix / Populus sp. charcoal						+**3**		++			+		+
? ancient charcoal	+++	+	++		+++					+			+
Conifer indet. charcoal								+					
charcoal indet.								+	+	+			
wood-uncharred	++	+		+	++++	++	+++	++++			+	+	
bark - charred			+	+	+	+					+		
bark - uncharred				+		+	+	+					+
fused plant ash	++++	++++	+++++	++	++		++	+	++	+	+	+	
straw frag - charred	+++	+++	+++++	+	++				++	++	++++		+
straw frag - partially charred/ uncharred	+	+	++	+	++				+		+		
charred plant material								++				+	+
uncharred plant material	++++			+	+++	+	++						
mineral replaced plant material													++
Picea sp. needle - charred											5		
Picea sp. needle - uncharred						1			5				
Pinus sylvestris L. seed - charred											6		
P. sylvestris L. seed - uncharred	1 (3)			1	2	1	1						
P. sylvestris L. key - uncharred				1	5								
Pinus sp. bud scale from base of strobile - charred	1						1		1		14		
Pinus sp. bud scale from base of strobile - uncharred		4	14	55	44	16			2			1	1
Pinus sp. antheriferous scale/ male strobile - charred	1		3	1	14				2		77	1	1
Pinus sp. antheriferous scale/ male strobile - uncharred			7	29	9	15	1		9		5		10
Pinus sp. cone scale - charred					1								

sample/ context number	*73*	*76*	*85*	*107*	*374*	*423*	*600*	*603*	*651*	*726*	*761*	*767*	*912*
Pinus sp. needle - charred							1				1		
Pinus sp shoot -charred									1				
Cupressaceae (not *Juniperus* sp.) leaves and stem - charred									1		1		
Ranunculus section *Ranunculus* - charred								(2)					
Papaver dubium/ rhoes/ hybridum - charred											1		
Urtica dioica L. - charred					10	1	12	4	3		9 (1)		1
U. dioica L. - uncharred					310	9	65	138					7
Betula sp. seed - charred	1		1		3		1				16		
Betula sp. seed - uncharred	2			1	18		1	2					
cf. *Betula* sp catkin - charred	1												
Betula sp. catkin - uncharred											1		
Alnus glutinosa (L.) Gaertn. - charred			1		2								
A. glutinosa (L.) Gaertn. - uncharred		1			1	1							
A. glutinosa (L.) Gaertn. Fruiting catkin frag. - uncharred						1							
Arenaria serpyllifolia L. - uncharred								8					
Stellaria media gp. - charred											(1)		
S. media gp. - uncharred					2			2					
Stellaria graminea L. - charred								2					
Cerastium sp. - charred									(1)				
Cerastium sp. - uncharred					7		2						
Scleranthus cf. *annuus* L. - charred											1		
Silene latifolia Poir. - charred					9	1	2	6					
S. latifolia Poir. - uncharred					29	2	3	6					
Silene sp. - charred							1				2		1
Caryophyllaceae indet. - charred	1				1 (1)			2			1		(3)
Caryophyllaceae indet. - uncharred							1	2					
Caryophyllaceae indet. -mineral-replaced								2					
Chenopodium cf. *album* - charred	1				1	1		2		1	9		1
C. cf. *album* - uncharred	1				32	3 (1)	11	14					1
Atriplex sp. - uncharred								2					
Chenopodiaceae indet. - uncharred					3			16					
Claytonia perfoliata Donn ex. Wild. - uncharred					2		1	4					
Polygonum aviculare agg. - charred					2						4		
P. aviculare agg. - uncharred					2								
Fallopia convolvulus (L.) Á Löve - charred								2					
Rumex acetosella agg. - charred					5	1	7	4			14		
R. acetosella agg. - uncharred	1				90	5	24	122					
Rumex sp(p). - uncharred					30								1

sample/ context number	*73*	*76*	*85*	*107*	*374*	*423*	*600*	*603*	*651*	*726*	*761*	*767*	*912*
Polygonaceae indet. - charred											1		
cf. *Salix* sp. bud - uncharred					1								
cf. *Descurainia sophia* (L.) Webb ex Prantl - charred							8						
cf. *D. sophia* (L.) Webb ex Prantl - uncharred					20	1	11	24					
Reseda luteola L. - charred					1	(1)	2		6		17		
R. luteola L. - uncharred	1												
Rubus section Glandulosus - uncharred					1								
Aphanes arvensis L. - charred					1		8	4			10		
A. arvensis L. - uncharred	1				16	1							1
small seeded Fabaceae indet. - charred					22	5 (1)	2	2			14	2	
small seeded Fabaceae indet. - uncharred					1								
Epilobium sp. - charred								(2)			5		
Pistacia vera L. - charred											15 frags		
Geranium sp. - charred							4						
Geranium sp. - uncharred							2	4					
Anthrisus caucalis M. Bieb - charred					16		7				3		
A. caucalis M. Bieb - uncharred					97	2	10	12					
Apiaceeae indet. - charred					4		1				1		
Myosotis sp. - uncharred					1								
cf. *Lamium* sp. - charred					1								
Lamium sp. - uncharred					2								
Glechoma hederacea L. - charred					5	1	3				2		
G. hederacea L. - uncharred					13	2 (1)	16	30					
Lamiaceae indet. - charred										2			
Lamiaceae indet. - uncharred					5								
Lamiaceae indet. - mineral-replaced								2					
Plantago cf. *media* L. - charred											1		
Veronica cf. *arvensis* L. - charred					2								
V. cf. *arvensis* L. - uncharred							1						
Euphrasia/ Odontites sp. - charred						1							
Campanulaceae indet. - uncharred					1								
Sambucus nigra L. - charred								10					1
S. nigra L. - uncharred					6	1							
Carduus sp. - uncharred							(1)						
Carduus/ Cirsium sp. - uncharred					6	1 (1)	1	4 (2)					
Sonchus asper (L.) Hill - charred					4		1						
S. asper (L.) Hill - uncharred						1							
Senecio sp. - charred											2		

sample/ context number	*73*	*76*	*85*	*107*	*374*	*423*	*600*	*603*	*651*	*726*	*761*	*767*	*912*
Senecio sp. uncharred					(3)		3	4					
Asteraceae indet. - charred								2			(5)		
Asteraceae indet. - uncharred					8 (1)						2		1
Cladium mariscus (L.) Pohl - charred											1		
C. mariscus (L.) Pohl leaf fragment - charred			1	38	13		2		189	9	11	1	4
C. mariscus (L.) Pohl leaf fragment - uncharred				2		2	1	3					
Carex spp. - charred					17	8	6	6	1		8	1	
Carex sp. - uncharred					29	2	17	16					3
Carex sp.perianth - uncharred								4					
Cyperaceae indet. - charred					1						3		
Poa annua type - charred						1					2		
Bromus sp. - charred								(2)					
Bromus sp. - uncharred					5		1	6					
small seeded Poaceae indet - charred				5	27	7	10 (8)		5 (1)	4 (1)	52	2	7 (2)
small seeded Poaceae indet - uncharred				1	27	6	14	6					1
large seeded Poaceae indet. - uncharred					1		3	32					
Poaceae indet rachis internode - charred			1										
Poaceae indet chaff - charred		3		20			1		2		(1)		
Poaceae size culm node - charred				4	2								1
Poaceae size culm node - uncharred							5	6					
Poaceae size culm base/ rhizome - charred				9	3		5		1	1			
Poaceae size culm base/ rhizome - uncharred					10		+++	19					3
Triticum aestivum L. rachis nodes - charred	39	28	34	2	3	1			74 (2)	15	2	5	1
T. aestivum L. rachis nodes - uncharred			1	1									1
T. aestivum L. terminal rachis nodes - charred	2								4				
Triticum sp. free-freshing type grain - charred	6	3	4						3	1			
Triticum sp. grain - charred		1					1						
Triticum sp. tail grain - charred			1										
Triticum sp. rachilla - charred	1	1	5		4				25	2	10		
Triticum sp. glume beaks/ short awns - charred/ silica	17	598	192	5	10	5	12	8	54	8	13	11	2
Triticum sp. glumes - charred/ silica	+	++++	++	+	+	+	+		++		++	++	
Triticum sp. glume base - charred/ silica	2			1	1					3			
Triticum sp. basal rachis node - charred/ silica	2			1					1				
Triticum sp. rachis internode - charred									7		1		
Hordeum sp, grain - charred					1								
Avena type awn - charred								8					
Cereales indet grain - charred	1	2			2		1		2			1	

sample/ context number	*73*	*76*	*85*	*107*	*374*	*423*	*600*	*603*	*651*	*726*	*761*	*767*	*912*
cf. Cereales indet grain - charred		1									1		
Cereal size culm node - charred	2	5	21				1		12		14		
Cereal size culm node - uncharred			1	2	3		3						
Cenococcum sp. sclerotia - charred					8		3	12	1		4		2
Cenococcum sp. sclerotia - uncharred					29	1	2	20					1
indet twig - charred					2						6	1	
moss capsule - charred	1										1		
moss - charred					1	1					1		
moss - uncharred					4								1
IGNOTA - charred	2		8	3	14	6	1		8	5	8	3	3
Frass - charred					+++			++	++	++	++++	+++	+
Frass - uncharred					++						++++		+
rabbit droppings - uncharred	3										1		
mouse droppings	1												
eggshell - charred											4		
eggshell - uncharred									1				

1 Includes some fragments with cut surfaces
2 Includes 1 pencil fragment
3 Three fragments of spilt roundwood which are twisted (split cane from basketry)
4 Includes to fragments of plank

Where the fine fraction was sub-sampled numbers have been multiplied up accordingly
Key: () indicate a tentative identification, + = up to 5 items, ++ 6–50 items, +++ 51–100, ++++ 101–500, +++++ >500

Table 5.2 Remains other than insects recovered in the samples analysed from the Farmer's House remains

Taxon	*c*	*t*	*f*	*Notes*
Context 73				
Amara aenea			1	entire apart from distal segments of appendages
Cryptophagus sp.	1			almost entire
Lathridius minutus group	1			
Corticaria sp.	1			
Coleoptera sp.	1			
Diptera sp. (adult)	s			one almost entire
Acarina sp.	m			
Context 76				
Diptera sp. (adult)	3			
Lathridiidae sp.	1			
Context 85				
Heterogaster urticae	1			
Diptera sp. (larva)	1			
Diptera sp. (puparium)	1			
Context 107				
Forficula auricularia			1	
Syntomus foveatus			1	
Kissister minima	1			
Tytthaspis (Micraspis) sedecimpunctata			1	
Philopedon plagiatus			1	
Formicidae sp.			1	
Hymenoptera sp.			1	
Insecta sp.	1			
Acarina sp.			2	
Context 374				
?Heterodera sp. (cysts)			m	
Oligochaeta spp. (egg capsules)			m	more than one kind
Diplopoda sp.			1	
Dermaptera sp.			1	
Heteroptera sp. (nymph)			1	
Cicadellidae sp.	1			
Diptera sp. (adult)			s	
Diptera sp. (puparium)	1		s	
?*Amara* sp.			1	
Calathus sp.	1		1	
Syntomus ?truncatellus			1	
Megasternum obscurum			4	
Cercyon analis			1	
Anotylus complanatus			1	
Bledius sp?p.			2	one larger, one smaller
Stenus sp.			1	
Othius sp.			1	
Gyrohypnus ?angustatus			1	
Xantholinus sp.			1	
Tachyporus sp. A			1	
Tachyporus sp. B			1	
Aleocharinae sp.			1	
Aphodius sp.			1	
Onthophagus sp.			1	
Meligethes sp.			1	
Simplocaria semistriata			1	
Anobium punctatum	2		2	
Corticaria ?pubescens			1	
Crepidodera sp.			1	
Otiorhynchus ovatus			1	
Philopedon plagiatus			1	
Sitona lineatus			1	
Sitona sp. indet.	1			
Euophryum confine	2		2	
Ceutorhynchus sp.			1	
?*Gymnetron* sp.			1	
Coleoptera sp.	1			
Coleoptera sp. (larva)			2	
Formicidae sp.			2	

Taxon	*c*	*t*	*f*	*Notes*
Hymenoptera sp.	1		2	
Insecta sp. (larva)	1			
Insecta sp. (cocoon)			1	sand-coated
Acarina spp.			s	
Gastropoda sp.		3?		
Context 423				
Oligochaeta sp. (egg capsules)			s	
Diptera sp. (adult)			m	two kinds
Diptera sp. (puparium)			3	
Carabidae sp. A			1	
Carabidae sp. B			1	cf Harpalus, Amara
Pselaphidae sp.			1	
Geotrupes sp.	1			
Aphodius sp.			1	cf granarius
Subcoccinella vigintiquatuorpunctata			1	
Phyllotreta sp.			1	
Otiorhynchus ovatus	1			
Philopedon plagiatus	1		2	
Euophryum confine			2	
?*Mecinus* sp.			1	
Formicidae sp.			2	
Hymenoptera sp.	1		1	
Insecta sp. (cocoon)			3	sand-coated; one contained a hymenopteran
Aranae sp.			1	
Acarina sp.	3		1	
Context 600				
?*Heterodera* sp. (cyst)	1			
Oligochaeta sp. (egg capsule)	1	s	1	
Forficula auricularia		1		
Heterogaster urticae	1			entire apart from wings and appendages
Lygaeidae sp.		1		
Philaenus spumarius	1			
Dipera sp. (adult)		1		
Diptera sp. (puparium)		s	1	
Amara sp.		1		
Harpalus sp.	1			
Megasternum obscurum		2		
Anotylus sculpturatus group		1		
Xantholinus sp.		2		
Elateridae sp.		1		
Mycetaea hirta		1		
Oulema melanopa		1		
Chaetocnema arida group		1		
Euophryum confine	2	5		one entire minus appendages
?*Coeliodes* sp.		1		
Cidnorhinus quadrimaculatus		1		
Curculionidae sp.	1			
Coleoptera sp.	1			
Formicidae sp.		1		
Insecta sp. (cocoon)		1	1	
Acarina sp.		1		
Context 603				
?*Heterodera* sp. (cyst)			m	
Oligochaeta sp. (egg capsule)			s	
Diptera sp. (adult)			2	more than one type
Diptera sp. (puparium)			s	more than one type
Calathus sp.			1	
Carabidae sp.			1	
Cercyon sp.			1	
Megasternum obscurum			3	
Stenus sp.			1	
Philonthus sp.			1	
Staphylininae sp.			1	
Aphodius sphacelatus			1	
Agrypnus murinus (larva)			1	
Ptinus fur			1	
Coccinellidae sp.			1	

Taxon	*c*	*t*	*f*	*Notes*
Otiorhynchus ovatus			1	
Euophryum confine	1		1	
Coleoptera sp.			1	
Aculeata sp.			1	
Insecta sp. (cocoon)			1	
Insecta sp.			m	unidentifiable cuticle fragments
Acarina sp.			2	
Context 651				
Heterogaster urticae	1			various sclerites
Cicadellidae sp.			1	forewing
Aphodius sp.	1			part charred ra + us fragment
Euophryum confine	2			le + hd
Coleoptera sp. (larva)	1			fragments
?Apoidea sp.			1	as
Insecta sp. (larva)	1			cf Lepidoptera, Symphyta
Acarina sp.	s		1?	
Gastropoda sp.		2?		1+fragments
Context 726				
Oligochaeta sp. (egg capsule)			1	
?Diptera sp. (puparium)	1			
Carabidae sp.	1			
Euophryum confine	2			
Acarina sp.	1			
Arthropoda sp.			1	indeterminate fragments of cuticle
Context 761				
Isopoda sp.	1			fragments, brown and very fragile, perhaps only calcareous part of cuticle remains?
Diplopoda sp.	1	1	1	
Forficula auricularia	2			cerci
Heterogaster urticae	1			
?Chrysopidae sp.				?lacewing egg capsule stalk
Lepidoptera sp. (larva)	2			almost entire
Lepidoptera sp. (pupa)	1			posterior end only
Siphonaptera sp.	1			entire minus appendages
Nebria brevicollis	2			
Leistus sp.	1			
Calathus fuscipes	4			
Amara tibialis	1			
Amara sp.	1			
Harpalus sp. A	1			
Harpalus sp. B	1			
?*Acupalpus* sp.	1			
Dromius linearis	1			
Carabidae sp.	1			fragments
?Hydroporinae sp.	1			
Coprophilus striatulus	1			
Gyrohypnus ?angustatus	6			mostly heads
Xantholinus sp.	2	1?		?toasted elytron
Tachyporus sp.	2			
Aleocharinae sp.	1			
Catops spp.	6			probably two spp
Sinodendron cylindricum	1			
Aphodius sp. A	2			
Aphodius sp. B	1			
Phyllopertha horticola	1			hind tibia
Prosternon tessellatum	1			
?Elateridae sp.	1			
Anthrenus sp.	1			entire minus appendages
?*Trixagus* sp.	1			
Anobium punctatum	9			
Ptinus sp.	1			probably P. fur
Carpophilus sp.	1			
Epurea sp.	1			
Cryptophagus sp. A	1			
Cryptophagus sp. B	1			
Aridius nodifer	2			
Lathridius minutus group	1			

Taxon	*c*	*t*	*f*	*Notes*
Corticaria ?elongata	2			
Corticaria ?punctulata	1			
Rhizophagus sp.		1		
?Coccinellidae sp.	1			
Phalacridae sp.	1			
Anthicus floralis	2			
Tribolium castaneum	1			
Phymatodes sp.	1			
?*Gracilia minuta*				leg segments
Otiorhynchus ?ovatus	1			fragments
Strophosomus ?melanogrammus	1			
Sitona ?lineatus	2			
Euophryum confine	e50			many entire apart from appendages
?*Gymnetron* sp.	1			
Curculionidae sp.	2			scales; cf Phyllobius and Polydrusus, probably 2 spp
Dryocoetes villosus	2			
Coleoptera sp. A	1			
Coleoptera sp. B	1			
Coleoptera sp. C	1			
Coleoptera sp. D	1			
Coleoptera sp. F	1			
Coleoptera sp. (larva)	1			
Diptera sp. (puparium)	3			
Parasitica sp.	2			
Formicidae sp.	9		1	probably three spp
Hymenoptera sp.	1			
Insecta sp. (larva)	3		1?	1? = cuticle fragments
Insecta sp. (pupa)	2			
Aranae sp. (ecdysed cuticle)			1	
Aranae sp.	2	1	1	fragments
Acarina spp.	s			
Gastropoda spp.	s			
Context 767				
?Isopoda (faecal pellets)	m			
Bibionidae sp.			1	
Diptera sp. (adult)			2	
Laemostenus terricola	1			
Stegobium paniceum			1	very fresh, with appendages
Euophryum confine	2			
Context 912				
?*Heterodera* sp. (egg capsule)			m	
Oligochaeta sp. (egg capsule)			2	
Diplopoda sp.			1	
Lygaeidae sp.			1	
Diptera sp. (adult)			s	more than one kind
Diptera sp. (puparium)			2	
?*Cercyon* sp.			1	
Micropeplus ?staphylinoides	1			
?*Sitona* sp.	1			
Euophryum confine	1			
Coleoptera sp.			1	
Formicidae sp.	1		2	
Aculeata sp.			1	
Acarina sp.			2	

The data from all the sub-samples have been combined. Numbers are summed MNIs, including semiquantitative estimates ‘many’ converted to 15, ‘several’ to 6 (see text)

Key: c – charred (some probably not fully carbonised); f – fresh (clearly uncharred and with no evidence of heating); l – length in mm (given for adult beetles and bugs, from Freude *et al*. 1964–1983 and Southwood and Leston 1959); pf – recorded in pitfall traps within buildings at West Stow (+ – present; ++ – at least moderately abundant; dash – not recorded in those traps so far recorded (not all data from the unpublished second study have been taken into account); t – ‘toasted’ (apparently heated but clearly not fully carbonised).
Numbers formatted e.g. >1?= indicate uncertainty as to state; >spp. indet.= indicates may include taxa listed above. Size categories: vs – very small, >1–2 mm; small, s – >2–5 mm; medium-sized, m – >5–10 mm; large, l–>10 mm. For some higher taxa, the size refers to the type(s) represented by the recovered remains, and for some species the extremes of length have been ignored. In some cases species only recorded in pitfall traps have been subsumed in higher categories (e.g. *Harpalus ?anxius* (Duftschmidt) within *Harpalus* spp.).

Table 5.3 Complete list of taxa from the samples from the Farmer’s House remains

Taxon	*c*	*t*	*f*	*pf*	*l*
?Heterodera sp. (cysts)	1	0	51	-	-
Oligochaeta spp. (egg capsules)	1	6	21	-	-
Isopoda sp.	1	0	0	++	-
?Isopoda sp. (faecal pellets)	15	0	0	-	-
Diplopoda sp.	1	1	3	+	-
Forficula auricularia Linnaeus	2	6	2	+	-
Heterogaster urticae (Fabricius)	4	0	0	-	m
Lygaeidae sp.	0	1	1	-	s-m
Empicoris sp. (nymph)	0	0	0	+	-
Heteroptera sp. (nymph)	0	0	1	-	-
Philaenus spumarius (Linnaeus)	1	0	0	-	s
Cicadellidae sp.	1	0	1	+	vs-s
Aphidoidea spp.	0	0	0	++	-
Lepidoptera sp. (larva)	2	0	0	+	-
Lepidoptera sp. (pupa)	1	0	0	+	-
Bibionidae sp.	0	0	1	-	-
Diptera sp. (adult)	9	1	31	++	-
Diptera sp. (larva)	1	0	0	+	-
Diptera sp. (puparium)	5?1	6	29	-	-
Siphonaptera sp.	1	0	0	+	-
Cychrus rostratus (Linnaeus)	0	0	0	+	l
Leistus sp.	1	0	0	-	m
Nebria brevicollis (Fabricius)	2	0	0	+	l
Pterostichus melanarius (Illiger)	0	0	0	+	l
Calathus fuscipes (Goeze)	4	0	0	+	m-l
Calathus sp. (not fuscipes)	1	0	2	+	m-l
Laemostenus terricola (Herbst)	1	0	0	+	l
Amara aenea (Degeer)	0	0	1	-	m
Amara tibialis (Paykull)	1	0	0	-	m
Amara (s. lat.) sp?p. indet.	1	1	?1	+	m
Harpalus spp.	3	0	0	++	m-l
?*Acupalpus* sp.	1	0	0	-	s
Dromius linearis (Olivier)	1	0	0	-	s
Syntomus (Metabletus) ?truncatellus (Linnaeus)	0	0	1	-	s
Syntomus (Metabletus) foveatus (Fourcroy)	0	0	1	-	s
Carabidae spp.	2	0	3	-	s-l
?Hydroporinae sp.	1	0	0	-	s
Cercyon analis (Paykull)	0	0	1	-	s
Cercyon sp.	0	0	1	-	s
Megasternum obscurum (Marsham)	0	2	7	+	s
Carcinops pumilio (Erichson)	0	0	0	+	s
Kissister minima (Aubé)	1	0	0	+	vs
Nargus sp.	0	0	0	+	s
Catops spp.	6	0	0	+	s
Micropeplus ?staphylinoides (Marsham)	1	0	0	-	s
Proteinus ovalis Stephens	0	0	0	+	s
Omalium rivulare (Paykull)	0	0	0	+	s
Dropephylla vilis (Erichson)	0	0	0	+	s
Coprophilus striatulus (Fabricius)	1	0	0	+	m
Bledius sp?p.	0	0	2	-	s-m
Anotylus complanatus (Erichson)	0	0	1	-	s
Anotylus sculpturatus group	0	1	0	-	s
Rugilus rufipes Germar	0	0	0	+	m
Othius sp.	0	0	1	-	s
Gyrohypnus ?angustatus Stephens	6	0	1	-	m
Xantholinus sp.	2	3	1	+	m
Staphylinus ater Gravenhorst	0	0	0	+	l
Philonthus sp.	0	0	1	-	m
Quedius spp.	0	0	0	+	m-l
Staphylininae sp.	0	0	1	+	m
Tachyporus spp.	2	0	2	-	s
Sepedophilus ?lusitanicus Hammond	0	0	0	+	s
Crataraea suturalis (Mannerheim)	0	0	0	+	s
Aleocharinae spp.	1	0	1	++	s
Pselaphidae sp.	0	0	1	+	vs
Sinodendron cylindricum (Linnaeus)	1	0	0	-	l
Geotrupes sp.	1	0	0	-	l
Aphodius spp.	4	0	2	-	m
Aphodius sphacelatus (Panzer)	0	0	1	-	m-l
Onthophagus sp.	0	0	1	-	m
Phyllopertha horticola (Linnaeus)	1	0	0	-	m-l

Simplocaria semistriata (Fabricius)	0	0	1	-	s
Prosternon tessellatum (Linnaeus)	1	0	0	-	l
Agrypnus murinus (larva)	0	0	1	-	-
Elateridae sp.	?1	1	0	-	m
Anthrenus sp.	1	0	0	-	s
Clambus pubescens Redtenbacher	0	0	0	+	vs
Anobium punctatum (Degeer)	11	0	2	++	s
Stegobium paniceum (Linnaeus)	0	0	1	-	s
Ptinus fur (Linnaeus)	?1	0	1	++	s
Carpophilus sp.	1	0	0	-	s
Meligethes sp.	0	0	1	-	s
Epurea sp.	1	0	0	-	s
?*Trixagus* sp.	1	0	0	-	s
Rhizophagus sp.	0	1	0	-	s
Cryptophagus spp.	3	0	0	++	vs-s
Phalacridae sp.	1	0	0	-	s
Subcoccinella vigintiquattuorpunctata (Linnaeus)	0	0	1	-	s
Tytthaspis (Micraspis) sedecimpunctata (Linnaeus)	0	0	1	-	s
Coccinellidae sp.	?1	0	1	-	s
Mycetaea hirta (Marsham)	0	1	0	-	s
Aridius nodifer (Westwood)	2	0	0	++	vs
Dienerella elongata (Curtis)	0	0	0	+	vs
Lathridius minutus group	2	0	0	++	vs-s
Lithostygnus serripennis Broun	0	0	0	++	vs
Corticaria ?elongata (Gyllenhal)	2	0	0	-	vs
Corticaria ?punctulata Marsham	1	0	1	-	s
Corticaria sp.	1	0	0	+	s
Lathridiidae sp.	1	0	0	-	s
Tribolium castaneum (Herbst)	1	0	0	-	s
Anthicus floralis (Linnaeus)	2	0	0	-	s
?*Gracilia minuta* (Fabricius)	0	0	0	-	s-m
Phymatodes sp.	1	0	0	-	m-l
Oulema melanopa (Linnaeus)	0	1	0	-	s
Crepidodera sp.	0	0	1	-	s
Phyllotreta sp.	0	0	1	-	s
Chaetocnema arida group	0	1	0	+	s
Otiorhynchus ovatus (Linnaeus)	1?1	0	2	-	m
Philopedon plagiatus (Schaller)	1	0	4	-	m
Strophosomus ?melanogrammus (Forster)	1	0	0	-	s-m
Sitona lineatus (Linnaeus)	?2	0	1	-	s
Sitona sp. indet.	1	0	0	-	s
Euophryum confine (Broun)	62	5	5	++	s
?*Coeliodes* sp.	0	1	0	-	s
Cidnorhinus quadrimaculatus (Linnaeus)	0	1	0	-	s
Ceutorhynchus sp.	0	0	1	-	s
?*Mecinus* sp.	0	0	1	-	s
?*Gymnetron* sp.	1	0	1	-	s
Curculionidae sp.	3	0	0	-	s
Dryocoetes villosus (Fabricius)	2	0	0	-	s
Coleoptera spp.	8	0	2	-	-
Coleoptera sp. indet. (larva)	2	0	2	-	-
Parasitica sp.	2	0	0	-	-
?Chrysopidae sp.	0	0	0	-	-
?Apoidea sp.	0	0	1	-	-
Aculeata sp.	0	0	2	-	-
Formicidae sp.	10	1	8	-	-
Hymenoptera sp.	3	0	4	-	-
Insecta sp.	1	0	15	-	-
Insecta sp. (cocoon)	0	1	5	-	-
Insecta sp. (larva)	5	0	1	-	-
Insecta sp. (pupa)	2	0	0	-	-
Acarina spp.	31	1	14	-	-
Aranae sp.	2	1	2	-	-
Aranae sp. (ecdysed cuticle)	0	0	1	-	-
Arthropoda sp.	0	0	1	-	-
Gastropoda spp.	6	5	0	-	-

Key: c – 'charred' (some probably not fully carbonised); f – fresh (clearly uncharred and with no evidence of heating); t – apparently 'toasted' (clearly not fully carbonised). The data from all the sub-samples have been combined. Numbers are MNIs. Quantification: m – 'many'; s – 'several' (see text). Numbers formatted e.g. '1?' indicate uncertainty as to state

Table 5.4 Insect remains from the Farmer's House remains listed by sample

IV. Discussion

(Plates 5.5–5.9, Fig. 5.2 and Table 5.5)

Preservation

Five different states of preservation are represented in the analysed samples: silicified, charred, toasted, uncharred and mineral replaced.

The few mineral-replaced plant remains present are almost certainly residual. Coprolites containing many macroscopic plant remains were found in SFBs and pits during the original excavations at the site (Walker 1985, 99). This, along with the poor condition of these remains, suggests that they are ancient.

The silicified remains range from fused plant ash (Plate 5.3) to well-preserved wheat glume beaks and short awns (Plate 5.5). The fused plant ash fragments are very brittle and it is likely that they would break up into much smaller solid fragments of fuel ash slag, fine ash and phytoliths as a result of compaction, water and frost action. This was observed to some extent in the material recovered from the flotation samples where only smaller fragments are present.

The wheat glume beaks and short awns are readily recognisable in the samples and closely resemble those present on the bread wheat used to thatch the roof of the building (Plate 5.1). These parts of the plant, along with other chaff such as glumes and culm nodes, survive well as silicified remains because of their high silica content. The glume beaks and awns in the West Stow samples include fully silicified examples, charred examples and specimens that are intermediate in nature (Plate 5.5). Silicified glume fragments, lemmas and paleas are also plentiful in some samples but were not quantified due to their fragmentary nature and the impossibility of providing any meaningful counts.

The presence of silicified remains is consistent with burning at high temperatures, above 800°C (M. Canti pers. comm.), in an oxygenating environment. Fused plant ash and silicified cereal remains are a particular feature of the specialist samples from the surfaces outside the building but some are present in nearly all the samples suggesting that this material is rapidly dispersed by natural processes.

A substantial proportion of the charred insect remains are in good condition, not showing too much distortion, and resembling oven-charred specimens (Kenward *et al.* 2008 and unpublished results). On the other hand, many of the charred insects are very fragmentary, and most of those which consist of more-or-less entire bodies are very fragile and have generally lost the appendages. Some of the specimens are so delicate that they broke during handling even with a soft paintbrush. A few seem to have formed 'char' and to be rather more substantial. It seems likely that these were still alive at the time of the fire, with tissues which boiled during heating and carbonisation, while the already dried-out corpses and dissociated sclerites simply charred. Specimens that were alive when charred, and thus formed a solid block of char, seem more likely to survive in archaeological deposits.

Comparing the results from pitfall trapping at West Stow (Kenward and Tipper 2008) with those obtained from this investigation, most of the insects for which more than one or two individuals were recorded from pitfalls were found charred and *vice versa*. The alien introduction *Lithostygnus serripennis*, abundant in the pitfalls, was not found charred, but it is a very small beetle whose remains might easily be overlooked; alternatively it may have invaded the remaining buildings subsequent to the fire. Those smaller species (vs and s in Table 5.4) which were abundant in the traps were generally considerably rarer in the charred assemblage, *Lathridius minutus* group and *Cryptophagus* species especially being surprisingly poorly represented. Taxa with a length above 2mm were generally about equally represented, within the expected variation between structures.

The charred plant remains include extremely well-preserved specimens that retain all their diagnostic features and show no visible distortion (Plate 5.6). These remains would be assigned as preservation index class 1 (perfect) and distortion index class 1 (no noticeable distortion) applying the index schemes in Hubbard and al Azm (1990). In contrast the cereal grain remains were generally very poorly preserved and showed some distortion. These grains would be assigned to preservation index 5 (identifiable by gross morphology only) and distortion index 3 (clearly distorted) under the same schemes.

However, as for the insect remains, a wide range of different levels of charring was observed. Some seeds were clearly more or less decayed before they were

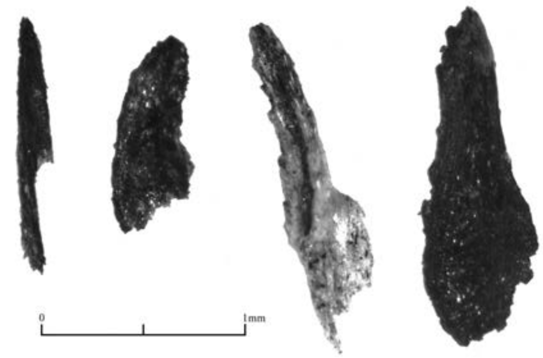


Plate 5.5 Silicified and charred glume beaks and short awns from context 423

Plate 5.6 Charred bread wheat rachis fragments from sample 76 showing near perfect preservation

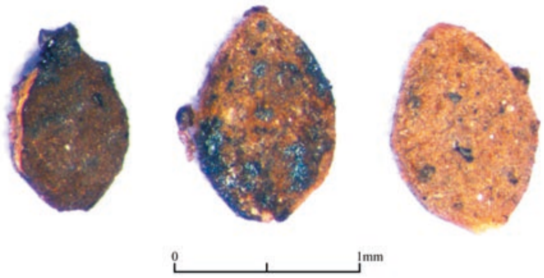


Plate 5.7 Nettle seeds (*Urtica dioica*) exhibiting varying degrees of preservation: left – the seed's contents are charred, but the surface is only toasted, centre – areas of the surface of the seed are fully charred in addition to the seed's contents, right – only tiny areas of the surface, or possibly material adhering to the surface are charred

charred, consisting of little more than a resistant seed coat, and these produced very delicate charred specimens that broke up easily. Sometimes the outside of seeds appeared uncharred while the contents were clearly fully charred (Plate 5.7 left). In other specimens some of the surface was fully charred as well as the contents (Plate 5.7 centre), while in other, decayed specimens, there was only superficial charring of the surviving seed coat or seed surface (Plate 5.7 right).

In terms of forming plant macrofossils within the archaeological record the delicate remains that broke up easily on handling would probably not survive. Only fully charred specimens and those exhibiting a degree of charring seen in Plate 5.7 centre and to a lesser extent Plate 5.7 left are relevant. Specimens showing only partial charring (Plate 5.7 right) would not survive long, or in a recognisable form, since the remaining tissue would be subject to rapid biological attack under normal burial conditions.

The observations suggest the state of a specimen, alive, dead or decayed, prior to charring plays an important part in determining whether it will be preserved

Plate 5.8 Pine needles poking out of the thatched roof of the Workshop (June 2010)

in recognisable state and will be robust enough to form part of the archaeological record. It is possible the poor preservation of many of the grains recovered from these samples is not due to charring conditions but rather that they were more or less decayed at the time of the fire. Any grains remaining within the wheat straw used to thatch the building would have been subject to biological attack and thus could have been in a poor state prior the fire. Such specimens might not form well-preserved macrofossil because little tissue was left to be preserved.

The remains described as toasted have clearly been heated sufficiently to be modified, showing alteration in colour and appearing browned or toasted. This condition is particularly evident in the insect remains but is also a feature of some of the plant remains, especially some of the wood. However in most cases it is difficult to distinguish between toasted plant remains and those that are just dried out. Such toasted remains are likely to have experienced temperatures less than or equal to 300°C above which charcoal formation occurs, though the duration of heating also plays a part (Wilson 1984, McParland *et al.* 2009).

Sources of material and deposit formation

The majority of the remains present in the samples derive from the building itself. Oak was the main timber used in the building while the roof was thatched with bread wheat (*Triticum aestivum)* straw. Thus we would expect these remains, in one form or another to be abundant in the samples. However, other remains in the samples are less easily related to the building and it is only because we know so much about the building, its contents and its surroundings that it is possible to identify probable sources for this material.

The four surface samples

These samples contain very few remains other than oak and cereal, although there is considerable variation between samples, both in terms of mode of preservation and content (Fig. 5.1). Other wood remains in these samples include five fragments of ash (*Fraxinus* sp.) charcoal which are readily recognisable as having been worked (sample 76), and fragments of hazel (*Corylus* sp.) roundwood (samples 73 and 85).

Ash poles were used as rafters in the roof of the building so this seems the likely source of these fragments (see Chapter 2). Similarly, hazel batons were also used in the roof with a number of partially charred and uncharred pieces found on the edges of the burnt area up to 2.00m from the wall-line (see Chapter 3). Thus the hazel roundwood charcoal, although showing no sign of working, is also likely to have originated from the roof of the building.

Other remains in these samples are likely to have become incorporated either because they were living on or in the thatch or had fallen onto the surface of the roof. For example, the nettle bug (*Heterogaster urticae*) in sample 85 may have entered the thatch to hibernate whilst the moss capsule in sample 73 could have come from moss growing on the thatch surface. The fragments of male pine cones (*Pinus* sp, strobile fragments) birch (*Betula* sp.) and possibly alder (*Alnus glutinosa)* were probably blown onto the roof or brought in on the feet of visitors or small mammals. Pine needles and strobiles are evident sticking into the thatch of the other buildings at West Stow and moss colonises over time (Fig. 5.2 and Plate 5.8).

More difficult to explain are the remains of saw sedge (*Cladium mariscus*) (Plate 5.9). Saw sedge was not used at all as a building material in the Farmer's House. However, three buildings at West Stow (the Oldest House, the Weaving House, and the Workshop) were thatched with saw sedge at the time of the fire (Letts 2004). The thatch on the Weaving House has been replaced completely with wheat straw over a base coat of heather (in 2006), the Workshop still retains a base coat of saw sedge (although a new surface coat of wheat straw was added in 2006), while the Oldest House also retains a base coat of saw sedge with a new surface coat of heather added in 2011(Fig. 5.2). In addition, there were large heaps of saw sedge at the time of the fire stored temporarily, under tarpaulin, immediately to the north of, and for the roof of, the new Hall, then under construction (in the event, the new Hall was thatched with rye over a base coat of heather in 2005). During thatching and the replacement of old thatch, large amounts of saw sedge would be lying on the ground around the buildings. Consequently, a probable source of the saw sedge in the samples is spent or replacement thatch. This could have blown in, into the side of the Farmer's House, and become trapped against the walls or in the root mat of plants growing near the building, especially the taller vegetation immediately under the eaves of the buildings (Fig. 5.2). This seems the best explanation for charred saw sedge remains in sample 107, with the charred grass (Poaceae remains) deriving from vegetation growing near the building.

Another aspect of these samples is the presence of 'ancient' charcoal (see above), particularly in sample 73. As the reconstructed village was built directly over the Anglo-Saxon settlement the most likely explanation is that this material is of Anglo-Saxon or earlier date and is being constantly re-worked by animal and human activity. Re-working by rabbits may be responsible for the number of fragments found in sample 73. On the other hand, this charcoal could represent the remains of fuel from the clearing out of hearths within the buildings or from bonfires lit on the site over the years since the village was reconstructed in the early 1970s. However, it seems likely that such relatively recent material would appear less worn than ancient charcoal (see below).

The few other remains in these surface samples may have arrived in the sample locations after the fire through the action of wind, rain and the ingress of humans and

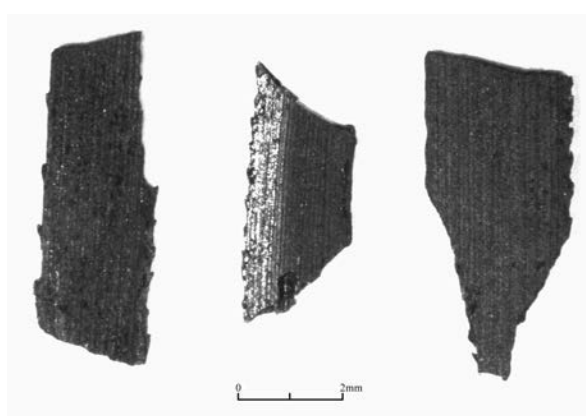


Plate 5.9 Fragments of saw sedge (*Cladium mariscus*) leaves from context 761

Figure 5.2 Plan showing the Farmer's House in relation to the nearest current sources of some of the plant remains recovered from the samples (June 2010)

animals. The uncharred rabbit and mouse droppings in sample 73 attest to post-fire occupation (see also Chapter 3) and it seems reasonable that the uncharred seeds of sheep's sorrel (*Rumex acetosella*), weld (*Reseda luteola*), and parsley-piert (*Aphanes arvensis)* in this sample could have been dispersed post-fire. However, it is also possible that they were present in the soil seed bank. This origin can be postulated for the charred fat hen (*Chenopodium album*) and Caryophyllaceae seeds.

The samples from the central pit (cellar)
Much of the material present in these samples is derived from the same sources as that recorded in the surface samples, though the contribution of the different sources varies according to the formation processes involved. Thus contexts 651 and 726 which formed during the fire and are situated below the collapsed cellar lining, contain very few remains other than those pertaining to the building itself.

The presence of predominately toasted insect remains in context 600 along with frequent uncharred grass rhizomes and culm bases and wood fragments suggests that this context may represent redeposited bits of the ground surface from immediately around the building. The temperatures experienced at the ground surface, especially within the roots and the base of the plants growing on this surface may not have been very great. Overlying ash, organic matter, compaction and moisture content all tend to reduce the conductivity of the soil and temperature can fall off very rapidly in soils directly below fires (Canti and Linford 2000). Seeds such as stinging nettle (*Urtica dioica*), white campion (*Silene latifolia*), and prickly sow-thistle (*Sonchus asper*), which are persistent within the soil seed bank (Salisbury 1961, cf. Akinola *et al.* 1998), are also present within layer 600 as well as species with less persistent seeds e.g. crane's bills (*Geranium* sp.).

Seeds in the soil seed bank, and potentially from plants growing under the eaves of the building also make a significant contribution to the assemblages from contexts 374, 423, and 603. These contexts also contain mainly uncharred insects and also the fungal sclerotia from the *Cenococcum* sp., indicative of burnt turves or sods (Hall 2003, 29). These layers were formed in part from the collapse of the building. They contain sediments, including the original backfill, from outside the cellar lining as well sediments eroded from the surface, so the importance of the soil seed bank and the surrounding vegetation within these contexts is not surprising.

Occasional artefacts, such as a charred fragment of pencil and three fragments of split willow or poplar (*Salix*/*Populus* sp.) found in the sample from context 423 would also be expected in layers representing the collapsed cellar lining. The three fragments of pine with cut edges in context 603 along with the other non-oak charcoal in this context might derive from cleaning out the hearth of the building during its use and/or the remains from other fires that took place since the village was reconstructed. The fact that these remains also appear fresh suggests that the worn and silvery charcoal fragments are indeed ancient. However, this distinction between the two types of charcoal fragments might not be as easy to make over time as the 'fresh' charcoal would suffer the effects of mechanical weathering and would gradually become more like its ancient counterpart.

The other context where seeds, probably mostly derived from the soil seed bank, are prevalent is in context 761. This layer also produced the largest assemblage of charred insects from the site. It contains various ground beetles, mostly single individuals, but at least two *Nebria brevicollis* and four *Calathus fuscipes*, both common in disturbed environments and caught in pitfall traps in the buildings at West Stow. All the remaining carabs might be found in open areas, providing there was some plant litter for *Dromius linearis* to shelter in. Plant-associated beetles include the chafer *Phyllopertha horticola*, the click beetle *Prosternon tessellatum*, and the weevils *Sitona ?lineatus* and *?Gymnetron*. Another weevil, *Strophosomus ?melanogrammus* (almost certainly this species) is most commonly found on shrubs and trees. There are also some species in the context found in decomposing matter, some normally in fairly foul conditions (*Gyrohypnus angustatus*, *Coprophilus striatulus*, though the latter appears to be part of a subterranean community in archaeological assemblages, Carrott and Kenward 2001), and some in drier matter and mouldy wood (*Cryptophagus* spp, *Aridius nodifer*, *Lathridius minutus* group, *Corticaria* spp.). The second group probably lived within the building, as probably did *Ptinus* sp., probably the common *P. fur*. The record of *Tribolium castaneum* is notable as it is a stored products beetle. It may have been brought in foodstuffs, or possibly in cereal thatch retaining caryopses which had been previously stored for some time (two other 'grain pests': *Sitophilus granarius* (Linnaeus) and *Cryptolestes ferrugineus* (Stephens) have been caught in pitfall traps at West Stow and are thought to have originated in this way). Also likely to have lived in the structure were some of the wood-borers: *Anobium punctatum*, *Euophryum confine*, *?Gracilia minuta*, and *Phymatodes* sp.). There are, in addition, fragments of timber beetles much more likely to have originated in rotting wood further afield (the small stag beetle *Sinodendron cylindricum*, *Rhizophagus* sp., and *?Trixagus* sp.). In contrast, the bark beetle *Dryocoetes villosus* may have been brought in under the bark of the timbers used to construct the building, or have invaded them after construction. Heat-altered remains were rare in the assemblage from context 761, the beetles being represented only by two which were possibly 'toasted'.

This deposit was interpreted as resulting from accumulation of sediment below the suspended floor during the life of the building. As such it would have acted as a pitfall trap for insects and also depository for buried seeds and material falling through from the floor above. For example: the charred spruce needles (*Picea* sp.) may have arrived on visitor's feet and then fallen or been swept between the floor planks. In addition, four months before the fire that destroyed the building, the base of the fire-box in the Farmer's House burnt through. This left a large gap in between the floor planks directly below the fire-box through which more material could fall (see Chapter 3; Plate 3.34). This incident could explain the range of different 'fresh' charcoal taxa found in the sample from this context (*Pinus* sp. *Abies/ Cedrus* sp., *Prunus sp.,* Pomoideae, *Betula* sp, and *Salix*/*Populus* sp.) as these taxa could be derived from remains within the fire-box. The broken pistachio nutshells (*Pistacia vera*) in the same sample, might have been thrown into the fire-box itself but could also have been dropped through the floor planks. The charred eggshell in this deposit might have arrived by the similar route, though the tendency of the village chickens to lay eggs around and within the building appears to have resulted in a general scatter of eggshell (context 651).

The size and richness of the assemblages from context 761 is likely to be a reflection of the time over which this layer was formed, i.e. over the life of the building. The contrast with layer 912 is interesting since this deposit is also thought to have formed during the building's use. Possibly 912 is largely the result of primary silting immediately after construction.

The number of charred items in context 761 as compared to the other layers may be because this layer was relatively loose and dry in comparison to the deposits external to the building. This layer would also have experienced considerable heating under reducing conditions due to the burning building collapsing onto it and the intense fire that developed in the pit (see Chapter 6; Wilson 1984, Canti and Linford 2000).

The pistachio nutshells are practically the only remains from the site that could be regarded as food remains, since in this case, bread wheat is being used as thatch. The exception to this is the single barley grain (*Hordeum* sp.) in context 374. It was very battered and poorly preserved and is almost certainly ancient (i.e. of archaeological origin). Barley grain was recorded in samples of Roman and Anglo-Saxon date from the main excavations at West Stow (Murphy 1985, table 44, 106). Some of the indeterminate poorly preserved grain may also be of Roman or Anglo-Saxon date, although these remains might also be decayed or damaged grain charred in the fire. Of more certain archaeological origin are the seed of annual knawel (*Scleranthus* cf. *annuus*) in context 761, and the red bartsia/ eyebright seed (*Euphrasia/ Odontites* sp.) in context 423. These specimens are both very worn and battered. *Euphrasia/ Odontites* sp. was recovered from SFB 63 at the main West Stow site, while *Scleranthus* cf. *annuus* was also recorded in SFB 63 and was frequent in the Roman samples (Murphy 1985, table 4, 106). Some of the other taxa that are only recorded charred in the samples from the current investigation may also be ancient (e.g. black bindweed *Fallopia convolvulus*), although given the condition of the specimens, and the fact that they are common plants, this is less certain.

Implications for interpretation

The numerous fragments of mature oak charcoal, some of which showed clear evidence of insect attack, along with the presence of wood boring insects, means that if these samples were examined as part of an archaeological investigation, with the knowledge that the deposits were likely to represent destruction layers the right conclusion would result. In other words, the interpretation of the charcoal assemblage would be that oak formed an important element of the building structure. Similarly, an examination of a range of samples would lead to the conclusion that bread wheat was used as a thatching material or at least that bread wheat straw was stored in the building. Having said this, if only a single sample was examined from the structure e.g. sample 76, a radically different interpretation might result, namely that the building was thatched with saw-sedge (Fig. 5.1).

Of more concern, however, is the interpretation of the assemblages from those contexts where plants growing around the building and seeds from the soil seed bank form a significant component. Taking context 374 as an example and using only those remains preserved by charring results in the species list presented in Table 5.5. We know that the sources of biological remains in the sample are likely to be from:

- The building itself — oak charcoal, wheat straw thatch
- Organisms living within or on the building structure — woodworm (*Anobium punctatum*), moss
- Organisms blown onto or against the building — saw-sedge, pine, birch
- Organisms brought in on visitor's feet or resulting from activities carried out close to the building — saw sedge, alder
- Organisms living close to the building — grasses, ground ivy (*Glechoma hederacea*), *Sitona* sp. *Calathus* sp.
- Organisms present within the soil, including seeds from the soil seed bank — *Cenococcum* sp., sheep's sorrel, stinging nettle
- Archaeological remains — barley grain, charcoal

(see Fig. 5.2 for the nearest current source of some of these plant remains).

However looking at the assemblage without knowledge of these sources, what is the likely interpretation? If the charcoal, other macroscopic plant remains and insect remains were considered together then the presence of structural oak timber that was damaged by woodworm infestation would be recognised. In contrast, the remains of saw sedge would probably be interpreted as evidence of thatching material.

With the identification of the 'ancient' charcoal undertaken and with the likelihood that some of the more delicate remains might not survive well over time, it would probably be postulated that the alder, birch and pine remains arrived along with the wood used for fuel with a comment to the effect that a variety of different woods were used for this purpose.

The remains of bread wheat chaff would probably be seen as resulting from the early stages of crop processing as well as some, if not the majority of the weed seeds. The presence of winnowing waste might be suggested given the presence of rachis fragments while the relatively large number of small weed seeds could be seen as the remains from fine-sieving (the waste from piecemeal cleaning of the grain).

It might be suggested that these by-products of crop processing were used as fuel given the presence of silicified and charred glume beaks and short awns, which are often taken as evidence for the burning of chaff. The presence of the single barley grain might be taken as evidence of the use of barley at the site as well as bread wheat, during this phase. The large number of small grasses, including rhizomes culm bases, along with the *Cenococcum* sp. Sclerotia, might lead to the suggestion that grasses and other vegetation were cut and used for fuel, or that there was evidence for the presence of dung or stable waste with the animals grazing on a number of habitats including marshland (due to the presence of sedges *Carex* sp.). It would probably be stated that some of the seed remains could equally have been growing in or

sample/context number	*374*
sample size in litres	20
percentage of sample analysed	100%
oak charcoal	+++++
?ancient charcoal	+++
bark - charred	+
fused plant ash	++
straw frag - charred	++
Pinus sp. antheriferous scale/ male strobile - charred	14
Pinus sp. cone scale - charred	1
Urtica dioica L. - charred	10
Betula sp. seed - charred	3
Alnus glutinosa (L.) Gaertn. - charred	2
Silene latifolia Poir. - charred	9
Caryophyllaceae indet. - charred	1 (1)
Chenopodium cf. *album* - charred	1
Polygonum aviculare agg. - charred	2
Rumex acetosella agg. - charred	5
Aphanes arvensis L. - charred	1
small seeded Fabaceae indet. - charred	22
Anthrisus caucalis M. Bieb - charred	1
Apiaceeae indet. - charred	4
Glechoma hederacea L. - charred	5
Veronica cf. *arvensis* L. - charred	2
Sonchus asper (L.) Hill - charred	4
Cladium mariscus (L.) Pohl leaf fragment - charred	13
Carex spp. - charred	17
Cyperaceae indet. - charred	1
small seeded Poaceae indet - charred	27
Poaceae size culm node - charred	2
Poaceae size culm base/ rhizome - charred	3
Triticum aestivum rachis nodes - charred	3
Triticum sp. rachilla - charred	4
Triticum sp. glume beaks/short awns - charred/ silica	10
Triticum sp. glumes - charred/ silica	+
Triticum sp. glume base - charred/ silica	1
Hordeum sp. grain - charred	1
Cereales indet grain - charred	2
Cenococcum sp. sclerotia - charred	8
moss - charred	1
Cicadellidae sp.	1
Calathus sp.	1
Anobium punctatum	2
Sitona sp. indet.	1
Coleoptera sp.	1
Hymenoptera sp.	1
Insecta sp. (larva)	1
Frass - charred	+++
IGNOTA - charred	14

Table 5.5 Charred remains recovered from the 20 litre sample taken from context 374

around the buildings and it might be suggested that turf or sods were being burnt.

The flaw in this interpretation is that it fails to take account of the input of the vegetation both growing on the site and contained within the soil seed bank, as well as material blown in or incorporated unintentionally on people's feet or re-dispersed from earlier human actions. It illustrates how hard it is to interpret assemblages correctly when the different sources of material in an assemblage are not fully understood.

V. Concluding remarks

The samples recovered from the burnt Farmer's House provide ample evidence for the principal timber used in its construction (oak) as well as some of the other structural elements such as the ash rafters and the hazel batons used in the roof construction. The bread wheat straw used to thatch the roof of the Farmer's House is also well represented in the samples both as charred, uncharred and silicified remains. Some of the building contents also survive in a recognisable form in the samples.

The vegetation growing around the building and seeds within the soil seed bank are also common as both charred and uncharred remains, especially within deposits containing material from behind collapsed cellar lining and in the main layer that built up in the bottom of the cellar when the building was in use. Material that had blown onto the roof or was brought in on people's feet forms an important component in some of the assemblages while other material probably originates from earlier activities carried out within or in the immediate vicinity of the building. Some intrusive material, probably of Roman or Anglo-Saxon date is also present.

Insects, charred and uncharred, also survive within the samples. The charred insects were very mixed ecologically, with abundant outdoor forms as well as some species likely to have originated within a structure. The range of strong synanthropes was very limited, only one (*Tribolium castaneum*) being rather unlikely to occur in natural habitats locally (it does rarely occur in the wild under bark, though apparently not as persistent populations). A number of the recorded taxa are common in low-grade buildings, notably the woodworm *Anobium punctatum*, which was present in moderate numbers, and *Lathridius minutus* group, *Corticaria* spp. and *Crytophagus* spp., but it would be foolish to divine the use of a structure on the basis of small numbers of such fauna. The remains in the burnt building were much less characteristic of structures than those recorded from pitfall traps by Kenward and Tipper (2008). The safest interpretation from the charred insect remains would be that it was the fauna of a semi-natural, disturbed, environment with stray synanthropes or dumping from nearby occupation.

When the full range of plant remains, including charcoal, in the analysed samples is considered and with the knowledge that the contexts sampled were destruction deposits, the presence of large amounts structural oak timber and wheat straw would lead to the interpretation that the destroyed building was made of oak timber and thatched with wheat straw. Some of the other components within the samples are more problematic in terms of archaeological interpretation but give clear evidence of the nature of the surroundings in which the Farmer's

House stood and of some of the activities that occurred in and around it.

The fact that seeds from the soil seed bank as well as material blown or walked into the site form significant components in the assemblages (e.g. 761) would suggest that the assertion that most charred remains on archaeological sites derive principally from crop processing or from other plants deliberately gathered and brought to the settlement (Hillman 1984; van der Veen 2007) does not hold true. Rather the results show that samples from around and within buildings may well contain charred seeds from the persistent seed bank as well as plants growing in close proximity to the buildings and that this needs to be considered in any interpretation.

Small compact seeds tend to be persistent in the soil seed bank (Fenner and Thompson 2005, 83) while the small 'heavy' weed seeds are also characteristic of a particular stage of crop processing: fine-sieving. This is where threshed crop is sieved through a mesh smaller than the grain to remove seeds, chaff fragments and other items (Hillman 1981; 1984; Jones 1984; 1987). The waste from this process is called the fine-sieving waste or by-product, and is often identified as being present on archaeological sites. Species such as sheep's sorrel, parsley-piert, knotgrass (*Polygonum aviculare*), and fat hen that are small and heavy and do not remain in seed heads (Small Free Heavy-SFH) along with species such as white campion, where the seeds are small and heavy but tend to remain in head (termed Small, Headed, Heavy-SHH) are typical of fine-sieving waste (Jones 1984; 1987). These are the exact same species that are present in the samples from West Stow and appear to derive from the soil seed bank. While these taxa are not obligatory segetal (arable) weeds (Jones 1987; Stace 1997), and the interpretation that fine-sievings are present is normally only made when these weeds are found along with cereal chaff, the potential for the misinterpretation is clear.

Many of the remains present in the samples are very delicate would probably not survive long unless rapidly and deeply buried, and might well break up during recovery, through excavation and sample processing. This is particularly the case for the insect remains but does not really explain why finds of charred insects from archaeological sites are so rare. On the other hand the observation that the state of an organism (alive, dead or decayed) prior to charring as well as the type and nature of the fire, may a factor in preservation is of interest and could be an avenue for further research.

VI. Vegetation survey of the Farmer's House enclosed area

by Rachel Ballantyne

(Plate 5.10, Figs 5.3–5.4 and Tables 5.6–5.7)

Introduction

A year after the Farmer's House excavation, the area enclosed to preserve the integrity of the site, and to protect visitors, showed clear vegetation patterning in relation to the original doorway (Plate 5.10). Although all the in-use experimental buildings at West Stow have bare and compacted doorway areas, this could be a direct result of underfoot trampling and crushing. In contrast, the vegetation patterns observed within the Farmer's House enclosure must reflect historic trampling patterns, since they emerged long after the fire, when all doorway-specific activities ceased.

Vegetation communities reflect the physical and chemical condition of soils, in addition to local climatic conditions (e.g. temperature, moisture and seasonality) and there are well-known traits associated with paths and trackways (e.g. Bates 1935; Davies 1938; Rodwell 2000). Trampling leads to surface compaction, which reduces water permeability and thus has a subsidiary geochemical impact. Both soils and flora have also been shown to act as a form of landscape 'memory' by reflecting historic patterns of human activity (Brooks and Johannes 1990).

Doorway soil compaction could further have archaeological significance, as physical and chemical signatures might transfer down the soil profile, creating a subsoil 'shadow' recoverable on truncated archaeological sites; this possibility was the research objective for the associated geoarchaeological sampling (Whaley 2008; see Chapter 4). A secondary objective was to contribute floristic data for interpretation of the charred and uncharred flora recovered by bulk sampling on the Farmer's House excavation.

The following sections outline the methods used, the range of flora recorded, and the distribution of different habitat types in relation to the doorway.

Methods

Surveying took place within the enclosed area on 14 August 2006 and 11 May 2007. During the first survey, soon after patterning of flora around the entrance was first observed, a number of flora could not be identified with confidence as they were either in seed or dying-back in the summer heat. The second survey was timed for identification of as many flowering plants as possible, just

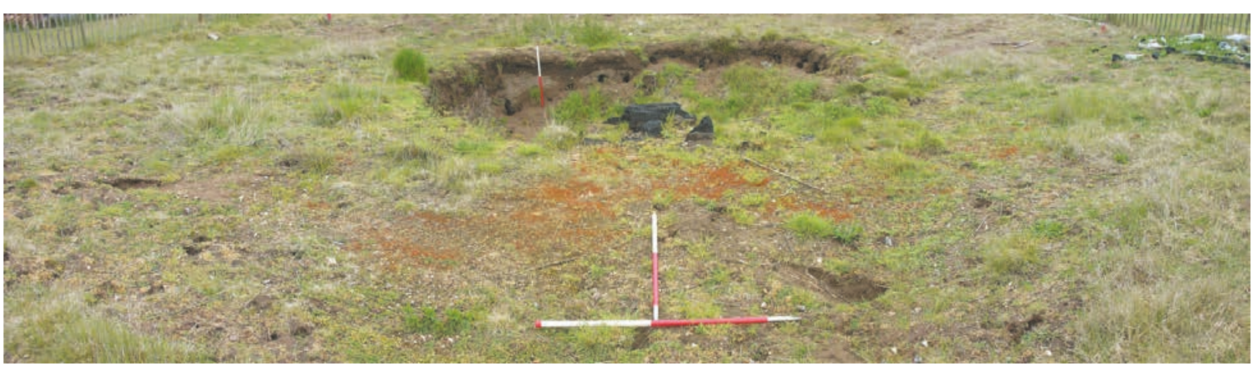


Plate 5.10 The vegetation survey area, 11 May 2007 (viewed from S)

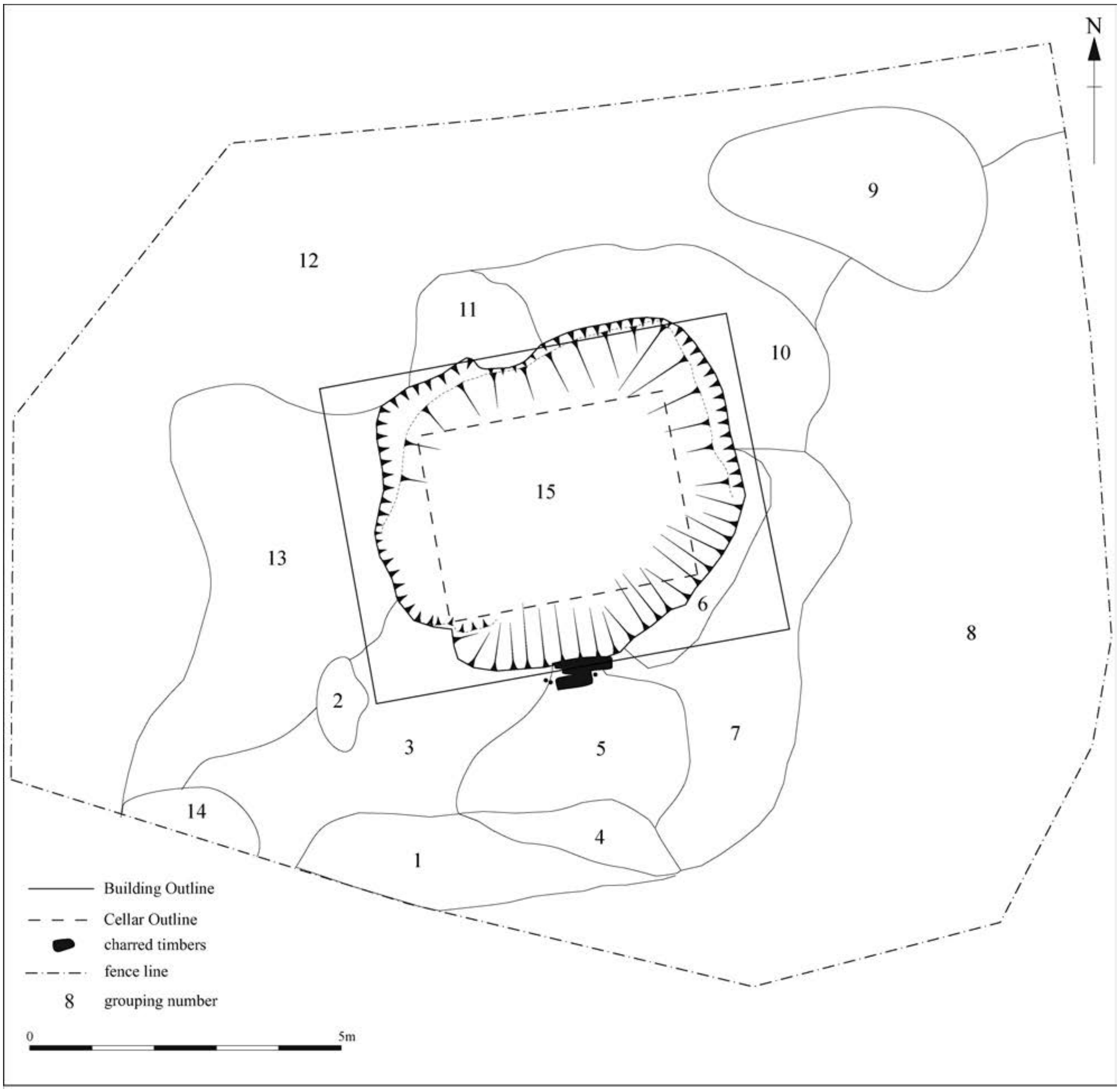


Figure 5.3 Distribution of vegetation groupings within the survey area

before instigation of the reconstruction works. During the second survey, a number of geoarchaeological samples were collected along E–W and N–S transects in the enclosed area.

The enclosed area was planned at 1:50 by offsetting with tape measures and hand-drawing onto permatrace. Each broadly coherent vegetation type was ascribed to a grouping and planned. All the constituent flora for each grouping were identified and recorded as a percentage of that area. The results are presented in Table 5.6 and Fig. 5.3. Identifications were made in the field using Rose (1981), with specimens collected of ambiguous types. The moss was later identified following Atherton *et al*. (2010), and all vascular plant taxonomy in this report follows Stace (1997).

Interpretation of the flora included comparison with flora recorded for the surrounding Country Park (Gregory 2008) and in particular the Ellenberg values quoted in Hill *et al*. (2004). Table 5.7 summarises the percentage range of each habitat type within the different vegetation groupings.

Range and distribution of flora

The range of flora is typical of dry, sandy disturbed soils in open locations, and all but one of the taxa are recorded from the surrounding Country Park (Gregory 2008). The ranges of ecological types are summarised in Fig. 5.4, and the most frequently represented species across all the vegetation groupings are sheep's sorrel (*Rumex acetosella*), bird's-foot (*Ornithopus perpusillus*), hare's-foot clover (*Trifolium arvense*) and ribwort plantain (*Plantago lanceolata*). The only plant not also recorded from the Country Park is annual pearlwort (*Sagina apetala*), which is commonly found on dry bare ground. Therefore, despite the wide range of activities associated with the use of the building, most if not all of the flora are possible natural colonisers.

Taxonomic name	English name	Habitat notes	Ellenberg values			
			L	*F*	*R*	*N*
Bare ground			-	-	-	-
Bryophytes (mosses)						
Ceratodon purpureus (Hedw.) Brid.	Fire moss		-	-	-	-
Angiosperms (flowering plants)						
Urtica dioica L.	Stinging Nettle	nitrogen indicator	6	6	7	8
Chenopodium album L.	Fat-hen	nitrogen indicator	7	5	7	7
Stellaria media L.	Chickweed	shaded places	7	5	6	7
Stellaria graminea L.	Lesser Stitchwort	grassy dry	7	6	5	4
Sagina apetala Ard.	Annual Pearlwort	dry bare ground	9	4	6	3
Silene latifolia Poir.	White Campion	light open soils	7	4	7	6
Rumex acetosella L.	Sheep's Sorrel	acid sandy soils	7	5	4	3
Capsella bursa-pastoris (L.) Medik.	Shepherd's Purse	open ground	7	5	7	7
Teesdalia nudicaulis (L.) W.T. Aiton	Shepherd's Cress	open sand/gravel	8	3	2	2
Reseda luteola L.	Weld	open ground	7	4	8	6
Sedum acre L.	Biting Stonecrop	walls, open grassland, sand	8	2	7	2
Ornithopus perpusillus L.	Bird's-foot	dry bare sand/gravel	7	4	4	3
Vicia hirsuta (L.) Gray	Hairy Tare	rough grassy places	7	5	6	6
Medicago lupulina L.	Black Medick	rough grassy places	7	4	8	4
Trifolium repens L.	White Clover	rough grassy places	7	5	6	6
Trifolium arvense L.	Hare's-foot Clover	rough grassy places	9	3	5	2
Epilobium sp. (immature)	Willowherbs	-	-	-	-	-
Geranium molle L.	Dove's-foot Crane's-bill	bare grass patches or disturbed	7	5	6	5
Erodium cicutarium (L.) L'Hér.	Common Stork's-bill	bare grass patches or disturbed	8	4	6	4
Anthriscus caucalis M. Bieb.	Bur Chervil	open sand/gravel	7	5	6	5
Myosotis sp. (in seed)	Forget-me-knots	-	-	-	-	-
Cynoglossum officinale L.	Hound's-tongue	open sand/gravel	8	4	8	6
Plantago coronopus L.	Buck's-horn Plantain	bare places or sand/gravel turf	8	6	6	4
Plantago major L.	Greater Plantain	open or rough ground	7	5	6	7
Plantago lanceolata L.	Ribwort Plantain	grassy places	7	5	6	4
Veronica officinalis L.	Heath Speedwell	grassland and heathland	6	5	4	4
Galium verum L.	Lady's Bedstraw	dry grassy places	7	4	6	2
Galium aparine L.	Cleavers	open ground	6	6	7	8
Cirsium arvense (L.) Scop.	Creeping Thistle	rough grassy places	8	6	7	6
Lapsana communis L.	Nipplewort	rough grassy places	6	4	7	7
Hypochaeris radicata L.	Cat's-ear	grassy places	8	4	5	3
Hypochaeris glabra L.	Smooth Cat's-ear	grassy/open ground if sandy	8	4	4	2
Leontodon autumnalis L.	Autumn Hawkbit	grassy places	8	6	6	4
Sonchus asper (L.) Hill	Prickly Sow-thistle	rough grassy places	7	5	7	6
Taraxacum spp.	Dandelions	-	7	5	7	6
Filago vulgaris Lam.	Common Cudweed	bare-ish places on sandy soil	7	4	6	4
Conyza canadensis (L.) Cronquist	Canadian Fleabane	rough grassy dry places	7	4	7	6
Senecio vulgaris L.	Groundsel	open and rough ground	7	5	7	7
Carex arenaria L.	Sand Sedge	open sand/gravel	8	3	5	2
Festuca rubra L.	Red Fescue	grassy places	8	5	6	5
Lolium perenne L.	Perennial Rye-grass	rough grassy places	8	5	6	6
Poa pratensis L.	Smooth Meadow-grass	rough grassy places	7	5	6	5
Holcus lanatus L.	Yorkshire Fog	rough grassy places	7	6	6	5
Bromus hordeaceus L.	Soft Brome	grassy places	8	4	7	4
Elytrigia repens (L.) Desv. ex Nevski	Common Couch	rough grassy places	7	5	7	7

Key for Ellenberg values: L – light; F – soil moisture; R – soil reaction (pH); N – nitrogen

Table 5.6 All recorded flora across the 15 vegetation groupings

Vegetation groupings by number															No. of cases
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	
40	10	25	10	25	10	12	1	10	10	5	2	10	3	90	14
	15			40	5			20							4
< 1			< 1							30				2	4
														1	1
											1	5			2
						2			15						2
		2													1
				1		< 1	< 1			10		1		1	6
2		15	5	1		5	1	10		2	20	5	10		10
		1													1
					5										1
							< 1						1		2
			1	1		1									3
1	10	5	5	2		10			10	5	2	10			9
					4				1	1		2			4
2	5	15	10	1		15	2		10		1	5			9
									< 1						1
30	5	10	55	2		10			< 1	< 1		15			9
					1										1
					5	1	5		5	5		< 1		< 1	7
						5									1
														2	1
					< 1										1
			< 1	< 1										< 1	3
		5	1	5		< 1			2	1		3			7
						2			2	1					3
5		2				5	20	20	5	15	20	3	10		10
		1	< 1												2
			< 1												1
						< 1									1
		1		1		1	1		2			2			6
											< 1				1
	30	5					1				2			1	3
< 1													< 1		2
	5	2			2	2	1				1		5		7
		< 1		1	1	1			1	< 1					6
			< 1	< 1		1	1			1	4				6
	5												20		2
15			< 1	2		5			1	< 1		1			7
			2				< 1				2	2	< 1		5
1			1	< 1											2
	10					5	5					1		1	5
				< 1											1
		10	5	15	60	10	1	40	10	20	30	20	20		12
2	5		2		5	5	60		20		15	10	30	1	11
												5			1
1					2				5	2					4

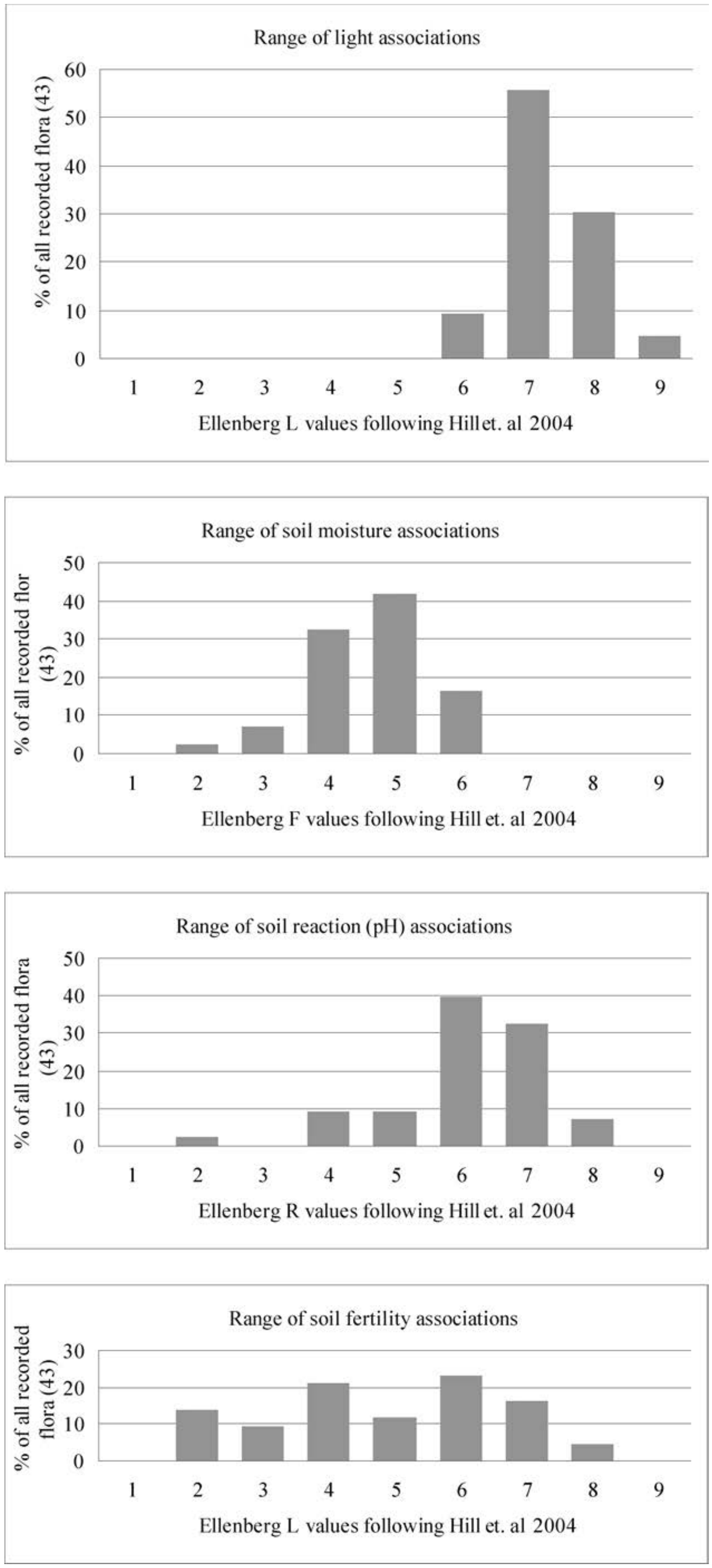


Figure 5.4 Ellenberg values for all recorded flora in the survey area

			Vegetation grouping															No. where dominant
			1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	
% Bare soil			40	10	25	10	25	10	12	1	10	10	5	2	10	3	**90**	1
% Moss				15			**40**	5			20							1
% of vegetation with each Light (L) value	semi-shade to well lit	6	0.5	0	1	1	0	0	0.5	0	0	0	30	0.5	0	0	2	0
	well lit, rarely partial shade	7	28	25	**48.5**	30.5	**23.5**	**77**	**62.5**	**91.5**	**70**	**85.5**	**63**	**95**	**64.5**	**91.5**	5.5	11
	light-loving	8	1.5	**45**	13	3.5	8.5	7	14.5	8	0	4	1	3	11	5.5	2.5	1
	full sun-loving	9	**30**	5	12	**55**	2	0	10	0	0	0.5	0.5	0	15	0	0	1
% of vegetation with each Reaction (R) value	moderate acidity	2	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
	acidic to neutral	4	3.5	10	**21**	10.5	3	0	15	1	10	10	7	22	15	10.5	0	0.5
	acidic to rarely basic	5	**31**	**35**	15	**56**	2.5	0	12	1	0	15.5	0.5	2	15	0	1	3
	acidic to basic	6	7	25	**21**	8.5	**20.5**	**76**	**35.5**	**92**	**60**	**45.5**	43	**67**	**44.5**	**85**	4.5	8.5
	weakly acid to weakly basic	7	16.5	0	2.5	4.5	6.5	3	10	3	0	9	**44**	6.5	11	0.5	4	1
	weakly acid to basic	8	2	5	15	10.5	1.5	0	15	2.5	0	10	0	1	5	1	0.5	0
% of vegetation with each Moisture (F) value	dry ground	2	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
	dry to rarely moist	3	31	5	10	**56**	2.5	5	10	0	0	0.5	0.5	0	15	0	0	1
	dry to moist	4	18.5	**50**	27	16.5	6.5	0	**35.5**	4	0	21	15.5	5.5	22	21.5	2.5	3
	moist-site indicator	5	8	10	**29.5**	13	**18**	**72**	30	33.5	**70**	29.5	**47.5**	**77**	**38.5**	**40.5**	4.5	7
	moist to damp	6	2.5	10	8	3.5	6	7	11	**62**	0	**39**	31	16	15	35	3	2
% of vegetation with each Nitrogen (N) value	infertile	2	31.5	5	10	**57.5**	3.5	5	11	0	0	0.5	0.5	0	15	0.5	0	2
	more or less infertile	3	3	**40**	**27**	10	3	0	15	2	10	10	7	24	15	10	1	2
	more or less fertile	4	7	15	25	11.5	6	2	**29.5**	23	20	**32**	16	22	16	35	0	2
	intermediate fertility	5	2	15	10	7	**15**	**70**	21	**71**	40	**35**	25	**45**	**31.5**	**50**	4.5	8
	fertile	6	15	0	1.5	1.5	6.5	5	8.5	3	0	5.5	13	4	6	1	1.5	0
	richly fertile places	7	1	0	1	2	0	2	2	0.5	0	7	3	3.5	7	0.5	1	0
	very richly fertile	8	0.5	0	0	0.5	0	0	0.5	0	0	0	**30**	0	0	0	2	1

Grey entries indicate groupings where bare ground or moss comprises the majority of a particular grouping

Table 5.7 Summary of habitat traits within the different vegetation groupings

Fig. 5.4 further shows that only one Ellenberg indicator value — that for soil fertility (F) — shows marked variation across the survey area. Soil fertility is a direct reflection of the quantity of nutrients that may be assimilated by plants, notably nitrogenous compounds. All the other habitat variables are dominated by a particular type or range of types, with light (L) showing the least variation. When this variability in fertility values is mapped by the dominant type within each vegetation grouping (those highlighted in bold in Table 5.7) those closest to the doorway indicate the lowest values. The doorway area also had a very high percentage of bare soil, and colonisation by fire moss (*Ceratodon purpureus*). Overall, the pattern matches closely with the known effects of trampling noted in the introduction, and would appear to be a floristic 'shadow' of the historic use of the doorway.

Other traits of note in the vegetation distribution include the large clump of nettles (*Urtica dioica*) to the east of the cellar pit, which suggests a nutrient-rich area perhaps linked to refuse or faeces. In addition, many of the recorded plants are perennials, and may have survived the fire as underground roots and rhizomes that later resprouted; thus providing a competitive advantage over annuals that spread by seed. For example, common couch (*Elytrigia repens*) is found by the walls and floorboards of a number of the active experimental buildings, such as the Living House a few metres to the west, and was found in greatest amounts by the edge of the building pit in vegetation groupings 6, 10 and 11.

In conclusion, it is clear that the bare topsoil at the entrance to a building can develop a strong trampling signature after a relatively short period of time (1998 to 2005, in the case of the Farmer's House). Although the experimental buildings at West Stow are not permanently occupied, regular visitor groups may well replicate the trampling that could be expected for a fully-occupied building, and the resulting recolonisation of the doorway area is with stunted plants that are tolerant of the nutrient-poor conditions associated with bare, compacted sandy soils. A number of the colonising plants are types that are common 'pioneers' of disturbed soils, such as black nightshade (*Solanum nigrum*), fat hen (*Chenopodium album*) and chickweed (*Stellaria media*) that are also characteristic weeds of early arable farming – this highlights that the charred seeds of such plants could easily represent surface debris associated with inhabitated areas, in addition to arable weeds.

6. Application of Fire Investigation Techniques

by Karl Harrison

I. Introduction

The destruction of the Farmer's House represented a serious setback to the efforts made at West Stow to present a range of reconstructions of early Anglo-Saxon buildings, specifically SFBs. However, the burning has provided a unique opportunity to study in detail the elements of construction preserved following the fire.

This chapter advances a range of techniques by which more data might be gained from the burnt remains of the reconstructed SFB. It is hoped that this will serve to inform on the fabric and construction of the building, as well as on the origin, ignition, development and resolution of the fire which destroyed it. Furthermore, it is hoped that it will assist in establishing a toolkit of techniques that might be used by archaeologists in observing and assessing the remains of other structural fires in the archaeological record (Harrison 2008).

In particular, this work is intended to inform on the origin and processes of combustion within this experimental structure and, more generally, to exploit analytical techniques commonly applied in the field of forensic fire investigation in order to present a more mature understanding of the complexities of structural fire frequently encountered in the archaeological record. The conclusions reached regarding the burning of the Farmer's House are compared with the records of excavations of original burnt SFBs in Chapter 7.

II. Fire from first principles

A basic explanation of the physical processes of combustion is laid out in the first part of this chapter, before any such methods are discussed in detail. In particular, a clear comprehension of the underlying principles of structural fire is required in order to understand the more complex and dynamic patterns of combustion in buildings like the Farmer's House.

Much of this work is based on observation and research taken from fire investigation employed in a contemporary forensic context. Despite the difference in scenarios and building types, there remain clear parallels between the way in which fires are seen to have behaved in both contemporary and archaeological structures. Handbooks of fire investigation have sought in recent years to overtly champion a 'scientific', analytical approach. This is largely an effort to distance them from earlier, subjective, investigation based upon the experience of the individual fire investigator (Redsicker and O'Connor 1997; DeHaan 1997).

Means of heat transmission

Energy as heat can be transmitted through three (or arguably four) mechanisms: conduction, convection, radiation and direct flame contact. Given appropriate conditions of fuel and oxygen, any of these mechanisms might be responsible for the ignition of a structural fire.

Conduction has been defined as the transmission of thermal energy between associated molecules (Shields and Silcock 1987). The effects of conduction are most noticeable in solid material where molecular contact is at its closest (DeHaan 1997). Therefore, metal pipes and ducting running through a wall away from a fire might be responsible for a further point of ignition of suitable fuel some distance away (Cooke and Ide 1985).

Convection plays a vital role in fire development, as 70–80% of associated thermal energy is released via this process (Shields and Silcock 1987). Convection is the transfer of thermal energy by the movement of heated liquids or gases (Hall and Brakhage 1997). In large fires or BLEVES (boiling liquid evaporation explosions), the high fireball or 'firestorm' that accompanies the incident is an extreme illustration of fire propagated by convection (Redsicker and O'Connor 1997). The dangers posed by convection processes are not limited to such unusually powerful and dramatic fires. In his study of fatal domestic fires in the UK, Silcock found that the most commonly associated life hazard was posed by a blaze originating in the living room and spreading up the staircase (Silcock 1983).

The process of radiation differs radically in operation from both conduction and convection, in that it requires no intervening medium of transmission. In the case of radiated heat, the thermal energy is transmitted as an electro-magnetic wave (Hall and Brakhage 1997). This effect is perhaps most clearly communicated as being that feeling of warmth gained by standing in sunlight. Within the context of structural fires, radiated heat is frequently evident in the 'grilling effect' caused at ground level by flameover fire passing across the ceiling of a compartment (Redsicker and O'Connor 1997; see below).

In 'Kirk's Fire Investigation', DeHaan identifies a fourth mechanism of heat transfer; that of direct flame impingement (DeHaan 1997). While this distinction may be of use in practical terms to the fire investigator, in physical flame, contact acts as a combination of convective and radiative processes.

Forms of combustion

Whatever processes initiate a fire, once begun, it will act like a pump on the surrounding gases, causing a significant degree of air circulation (Fig. 6.1). The flame front requires fuel and oxygen to continue to propagate, causing heated, oxygen-depleted air to rise from the top of the fire. In the majority of fires, this hot air would be contaminated with combustion gases and unburnt solid fuel particles, forming smoke. This upwards motion of air causes negative pressure at the bottom of the column, which in turn results in a draw of heavy, cool, oxygen rich air into the fire to feed the cycle of combustion (Hinckley 1986).

The combustion process can be further distinguished into two distinct types, which may occur independently of one another, or can manifest within the same fire. The first of these, flaming combustion, is characterised by diffuse

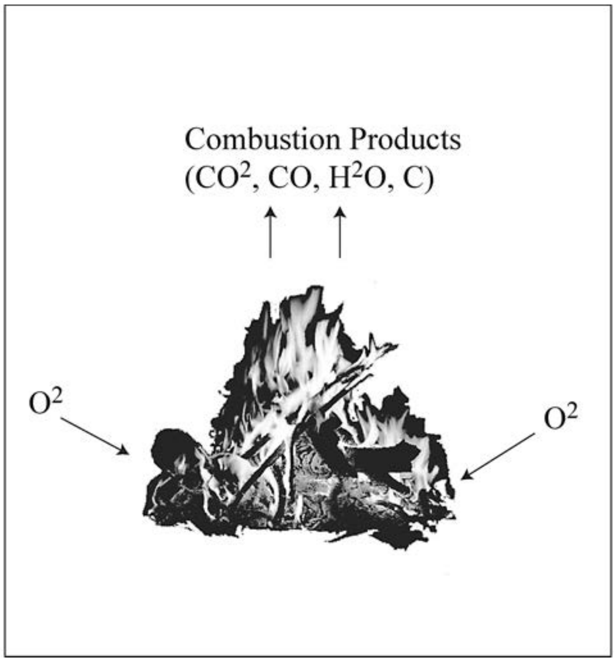


Figure 6.1 Illustration showing the action of fire on surrounding gases

flames that feed on volatile chemicals liberated by heat from available fuel. Flaming combustion can be characterised as being 'fuel dependent', in that it generally occurs in well-ventilated areas, and its continued survival and growth is determined by access to fuel.

Smouldering combustion, by contrast, is 'oxygen dependent', and tends to occur where oxygen levels are limited (such as down the side of an armchair), or where its fuel lacks chemicals sufficiently volatile to support flaming combustion (as in a charcoal barbeque). It has been described as a non-flaming, self-propagating combustion process (Shields and Silcock 1987). Due to their characteristic means of spreading, these two combustion types frequently leave distinctive patterns in surviving fire debris. As such, their identification can be extremely useful in establishing the conditions under which the fire developed.

Compartment fires

Fire scientists and investigators refer to blazes occurring in a room or other enclosed area as being 'compartment fires'. Regardless of differences in the geometry of compartments, or the fuel present, these fires form a distinct group, because of changes to their behaviour brought about through their spatial restriction.

In the early stages of fire development, before the restriction of space affects the fire, both open and compartment combustion display very similar patterns of growth (Thomas 1960). Allowed sufficient fuel, however, the compartment fire will ultimately be altered in its development by the limited amount of oxygen reaching it from ventilation sources, and its inability to expel partially burnt combustion products.

The fabric of the compartment itself may cause the temperature of the fire to rise; the internal surfaces of walls and ceiling causing the radiative feedback of thermal energy. Additionally, the compartment prevents the escape of hot combustion gases rising from the fire by convection (Buildings Research Institute 1991). Rather, these form a gas layer at the top of the compartment.

Eventually, this hot gas layer may reach a temperature sufficiently high to cause it to reignite. This is especially likely if the compartment fails in some way that allows more oxygen in without releasing the combustion gases (most commonly, this is seen in the failure of windows and doors in modern compartments). This increased oxygen causes the ignition of a sheet of flame across the ceiling of the compartment, known as 'flameover'. The flameover effect massively increases the degree of damage caused by the fire (DeHaan 1997).

An intense, rapid flaming compartment fire, followed by a flameover reaction may result in a relatively evenly burnt scene, with little or no evidence of a point of origin being preserved within the building remains. By contrast, a slow-burning, smouldering combustion may lead to significant degrees of highly localised damage at the origin point, evident even following the effects of a flameover (Cooke and Ide 1985).

A compartment fire will generally burn for longest and exhibit the greatest degree of damage at or near its point of origin, due to the optimal balance of fuel and oxygen enjoyed during the early stages of combustion (Redsicker and O'Connor 1997). This observation is far from conclusive, however. Supposed origin points, also referred to as seats of fire, may be discovered that do not represent points of origin, but rather are the remains of preferential areas of burning. These may be caused by a greater fuel load being present at that point, by better local ventilation, or by peculiarities of the compartment's geometry (Cooke and Ide 1985).

The action of convection gives fire damage a tendency to spread from low to high within a compartment. Therefore, evidence of the lowest points of burning may be indicative of the point of origin (Ide 1998). Such evidence is generally only revealed through excavation and sifting of fire debris (Cooke and Ide 1985; Redsicker and O'Connor 1997). Other forms of fire damage may complicate such interpretations, however. Flameover, the peak energy release point for compartment fires discussed above, can cause extensive low burning by radiation from the grill effect of the ignited hot gases at the top of the compartment (DeHaan 1997). Low burn patterns may also be imitated by burning items falling from higher locations in the compartment (Hall and Brakhage 1997).

Throughout this complex and changing process of combustion, thermal and mechanical forces cause damage to the fabric of the compartment and its contents, and the subsequent deposition of debris at its base. Just as with other formation processes in the archaeological record (Schiffer 1987), structural fire reflects a complicated relationship of destruction and preservation in its deposited stratigraphy. Such stratigraphy may preserve within it not only chronological information concerning the sequence of structural collapse, but also information concerning the nature and spread of the fire.

In contrast to the model of flameover development, which dominates the dynamics of fires observed in modern compartments, experiment suggests that contemporary constructs of archaeological structures are far less susceptible to this phenomenon. Observations of these fires suggest that they are far more likely to progress as an open fire in the initial stages, causing a rapid spread to the organic roof material, frequently by direct flame impingement, rather than through processes of convection or radiation. This rapid involvement causes a failure of the roof, and thus the compartment as a whole, frequently before the walls or more durable contents incur significant damage. Such fires never appear to become ventilation-dependent to any great degree (Harrison 2001; S. Dennis pers. comm.; Bankoff and Winter 1979).

Such fires as these, whilst they are clearly extremely destructive in terms of the damage to roof elements or high exposed timbers, rarely demonstrate a degree of sustained and intense thermal output, such as might be required to bring about a significant temperature-derived alteration to daub walls or earth floors. Rather, they are characterised by the survival of charred roofing elements collapsing within the walls, frequent survival of upstanding walls, and heavy timber char being restricted to exposed joints, angles and terminal ends of structural beams, where the surface area of fuel is greatest in relation to its mass. This limited destruction would seem to be sufficient to bring about structural collapse in some experiments. This collapse would appear, anecdotally at least, to favour the falling of wattle and daub panels outwards, away from the structure (Harrison 2001).

Considerations of fuel

Timber continues to feature as an important element in modern construction and furnishings. The important role it plays in effecting the fuel load of domestic fires and subsequently in the conclusions reached by fire investigators single it out for detailed discussion. As timber burns, it leaves an insulating layer of charcoal. This can act to protect the unburnt cores of large timber beams and uprights from further fire damage. Structural timbers might thus continue to bear heavy loads following a fire (English Heritage 1990).

Far from simply being a by-product of burning wood, charcoal is an impure carbon compound which may be evident when the more volatile components of wood have burnt away rapidly in flaming combustion, but when oxygen and temperature levels are insufficient to bring about total fuel combustion (DeHaan 1997). Charcoal is formed when wood is exposed to temperatures in excess of *c*.275°C, and its rate of production is highly dependent on the level of radiative flux received by the fuel.

Attempts to calculate a constant rate at which wood chars have proved unreliable when taken from test conditions into the context of a real fire environment. Such tests have assumed perfect (black body) radiation uptake by the wood surface, and make no allowances for the increasing insulating qualities of the deepening layer of surface char (Cooke and Ide 1985).

Other elements commonly found in timber, such as sodium, silicon, aluminium, calcium and magnesium generally remain following the complete consumption of carbon and other more volatile elements. In their oxidised state, these elements form ash, taking on a greyish-white appearance (Cooke and Ide 1985). Thus when looking across a fire scene featuring burnt timbers, the area will appear black with char when viewed from the periphery towards the seat of fire. By contrast, when looking from the seat out to the periphery, the scene will appear lighter, because the timber surfaces have been subject to more complete combustion on the visible, exposed side (Hall and Brakhage 1997).

It is the possession of an understanding of these mechanisms that lends the fire investigator a scientific basis on which to base conclusions regarding the cause, origin and development of a fire.

III. Modelling the dynamics of fire in the archaeological record

The superficial similarities between the investigation of a forensic fire scene and the excavation and understanding of an archaeological site have long been realised. Over the preceding twenty years, the importance of a multi-disciplinary approach to the investigation of fires of suspicious origin, shared between fire, police and forensic science agencies, has gradually come to be seen as crucial to the successful examination of fire scenes (Cooke and Ide 1985). In the UK, fire investigation teams comprised of specialist fire-fighters, police Scenes of Crime Officers and forensic scientists have a joint duty to investigate a range of fire types; including those of high value or potential suspicious origin, and those which have resulted in fatalities (HMSO 1983).

In general terms, a fire investigator will conduct an excavation of the suspected ‘seats’ or points of origin of the fire in question. Such an examination will aim to recover potential evidence associated with the ignition, as well as to identify characteristic signatures of burning, such as the lowest examples of heat damage within a room, or characteristic ‘V’ patterns of scorching, both of which are suggestive of early involvement in structural fires (Plate 6.1).

Plate 6.1 A contemporary fire. Circled areas highlight ‘V’ pattern and low burning (left), and heat shadowing from furniture (right))

This recognition of the importance of artefacts located at the base of the layers of destruction has led to a rudimentary appreciation of the importance of context and stratigraphy within fire investigation (Cooke and Ide 1985), although this has not, as yet, been developed in any systematic manner. Despite the obvious differences in aims and methodologies between archaeology and fire investigation, the overarching similarities between the two disciplines have been cause for comment in some of the standard forensic texts (Cooke and Ide 1985; Redsicker and O'Connor 1997).

Fire investigation can offer a number of systems by which the spread and development of structural fire in the archaeological record might be realistically modelled and better understood (DeHaan 1997). With regard to this understanding, it has been suggested previously that such modelling may inform not only specifically on the fire itself, but also on the building fabrics, architecture and human responses that surround it (Harrison 2004).

The understanding of fire within the discipline of archaeology would seem to be distributed unevenly. Whilst its relation to pyrotechnology is relatively well understood (Coles 1979), the examination of traces of structural burning in the archaeological record would appear to have offered few opportunities to investigate and exploit the methods of forensic fire investigation. Previous examinations of burnt structures in the archaeological record have been simplistic and frequently reduced to the observation of charcoal and burnt daub to indicate a structural fire (Perring and Roskams 1991; Harrison 2001). They have often relied upon literary sources to suggest a possible source for the blaze; Avery (1986), for example, refers to Caesar's *Gallic Wars* (Book II, 6.2), which reports how the Belgae set fire to the gates of Bibrax in 57BC (Edwards 1917, 99). In England, Tacitus' account of the destruction of Camolodunum during the Boudican Revolt in AD 60/1, in *The Annals* (Book XIV, 32) is often cited (Jackson 1969, 161). There is considerable archaeological evidence in Colchester of this event, in the form of a 'Boudican destruction layer' up to 0.50m in thickness (Crummy 1997, 79–84). Although there has been some meticulous excavation of many burnt buildings (e.g. Crummy 1984), the evidence has not yet been investigated in terms of forensic fire investigation.

There is a body of literature documenting experimental archaeology concerned with structural burning, which dates back to attempts to recreate the remains of 'vitrified' forts (Childe and Thorneycroft 1937). Other more recent experiments have continued to highlight an interest in this field within archaeology more generally, even where they have been frustrated in their conclusions. Hansen examined the remains of a burnt timber long-house at Lejre in Denmark, a formal experimental site (Hansen 1962; Rasmussen 2007), and Bankoff and Winter examined the burnt remains of a contemporary shepherd's hut of traditional design in the Morava Valley in Serbia (Bankoff and Winter 1979). The reported conclusions of both, however, were almost exclusively qualitative in nature. They communicated their observations of the respective fires rather than making an attempt to quantify the burnings in any way.

At Butser Ancient Farm in the UK, structural burning has occasionally formed a part of the experimental work undertaken. Reynolds (1994, 13) recounted the necessary abandonment of the Farm's original sites of Little Butser and Hillhampton Down. Amongst the experimental structures there, he notes that the Pimperne roundhouse was dismantled, whilst a smaller structure, the Moel-y-Gaer house, was burned down. Unfortunately, the burning of this smaller structure has not, to date, been published as a work of experimental research. Despite this fact, observations made during the dismantling of the Pimperne house, as well as subsequent study of retained soil samples, (Goldberg and Macphail 2006, 257) taken from the two structures represent valuable pieces of experimental work.

More recently, Stevanović (1996), working on burnt structures of the Balkan Neolithic, has attempted to use an understanding of fire science to ascertain 'fire paths' within the remains of burnt buildings. Whilst Stevanović's approach suggests a modification to the process of archaeological methodology in order to attempt to define a point of origin for the fires within these buildings, her focus is explicitly anthropological in nature. This focus enables her to explore the possible meanings behind the rash of house burnings in the Balkan Neolithic, but she does not develop this research further in an attempt to explore the potential these methodological changes might offer the archaeology of structural fire more broadly. No quantified model of destruction by fire has been constructed for any of the experimental or research projects.

IV. Fire in the Farmer's House

In assessing the fire at the Farmer's House, a range of fire investigation techniques has been applied to the excavated material. The aim of this work has been two-fold. Firstly, it seeks to provide a mature and quantifiable model of the origin, spread and resolution of fire through the building. Secondly, it examines the techniques of fire investigation themselves.

The raft of techniques employed by fire investigators relies largely on one of two characteristics of structural fire. The first of these groups of techniques seeks to locate those areas of a structure subject to the most intense burning, as these frequently reflect seats of burning, or areas of high fuel concentrations, or else places subject to high levels of ventilation (DeHaan 1997).

Other techniques of fire investigation analyse and collate directional indications of burning within a structure, which together may suggest a point of origin for the fire through patterns of smoke staining and scorching. Given that heavily charred timber and rubified material survives far more readily in the archaeological record than does unburned or lightly scorched timber, the intensity-related techniques are generally far more useful in examining fires in archaeological structures than are the directional-related techniques. As an experiment in the understanding of the archaeology of structural fires, the Farmer's House offered an unprecedented opportunity to compare results of both intensity-related and directional investigative techniques, and to discuss their various conclusions.

As a contemporary construct set amidst a range of alternative interpretations of Anglo-Saxon SFBs, the Farmer's House exhibited a particularly intense use of heavy timbers in its make-up. The dimensions of the structural timber employed in the reconstruction have been quantified (Table 6.1). Discounting the minor

Component (all timber oak unless otherwise specified)	*Quantity*	*Length (m)*	*Width (m)*	*Thickness (m)*	*Volume (m^3)*
Cellar lining (16 tangentially split boards)					
E/W sides (8)	8	3	0.36	0.06	0.52
N/S sides (8)	8	4	0.36	0.06	0.69
Outer joists (4)					
N/S sides	2	6.3	0.2	0.2	0.50
E/W sides	2	5.2	0.2	0.2	0.42
Central E–W joist	1	6.3	0.2	0.2	0.25
Joists for trapdoor	1	4.3	0.2	0.2	0.17
Joists for trapdoor (2)	2	1	0.2	0.2	0.08
Ridge-posts (2)	2	6.25	0.18	0.18	0.41
Corner-posts (4)	4	4.5	0.18	0.18	2.59
Central supporting posts in cellar (2), each *c.*0.20m in diameter and left in the half round	2	1.8			0.06
Central (N–S) joist	1	2.75	0.18	0.18	0.09
Door-posts (2)	2	2.4	0.18	0.18	0.16
Ridge beam	1	7.2	0.18	0.18	0.23
Wall-plates (2)	2	7.2	0.18	0.18	0.47
Upper Purlins (2)	2	7.2	0.18	0.18	0.47
Tie beams					
Lower (main) ties (2)	2	5.2	0.18	0.18	0.34
Upper (main) ties (2)	2	3.25	0.18	0.18	0.21
Lower (outer) ties (2)	2	5.2	0.18	0.18	0.34
Upper (outer) ties (2)	2	3.25	0.18	0.18	0.21
Floor (21 tangentially split planks, each 5.00m long x 0.25–0.40m wide x 0.10m thick (max.))	21	5	0.25–0.40	0.1	3.41
Wall boards (*c.*388m of radially-cut planking, each *c.*0.25m wide x 0.10m thick (max.))	151	388	0.25	0.1	9.70
N wall		88			
S wall		70			
E/W walls (2)		115			
Total volume of structural timber (m^3)					**21.31**
Volume of structure, discounting cellar and floor (m^3)					**16.68**

Table 6.1 Dimensions of structural timber by component in the Farmer's House

timbers, thatched roof and internal fittings, these figures offer a chance to suggest an approximate quantification of the fuel available to the fire within the fabric of the Farmer's House.

These calculations offer approximations of the volume of fuel available to the fire in the form of structural timber. To convert this approximate volume to a calculation of mass which is crucial to later considerations, a putative mass of 800kg per m^3 of oak (Anon 2008a) gives a total of 13,347kg of structural timber, distributed over a $35m^2$ footprint of building. This gives an average fuel load of 381.3kg per m^2 of structure.

The loading of fuel across the structure, both in terms of its total flammable load and its distribution, is crucial to the understanding of the development of the fire. In comparison, the average fuel load per square metre of the Farmer's House is far in excess of the range suggested as being an average for modern structures, between 16–25kg/m^2 (Cooke and Ide 1985, 10). This massive difference is explained partly by the entirely organic nature of the building and partly by the height of the structure, which with the depth of the cellar might be as much as three times of the weighting per m^2 compared with a modern single-storey compartment.

The destructive potential of this fire cannot be overstated in comparison with the concentrations of fuel generally encountered in modern structural fires. Law's Law (Cooke and Ide 1985, 10) has quantified the requirement for fire resistance in compartments as follows:

$$Tf = K.\frac{L}{\sqrt{A_w\ A_t}}$$

where:

Tf = Time in minutes a compartment fire might burn at full intensity
K = An experimental constant approximating unity
L = Total available fire load, in kg timber equivalent
A_w = Window area (m^2)
A_t = Sum of wall and ceiling area, in m^2, excluding A_w

By utilising Law's Law in a modern context, Cooke and Ide suggest the following figures as an average level of peak fire intensity:

$$1 \times \frac{240}{\sqrt{3 \times 48}} = 20$$

The product of these calculations is a figure that, were a modern compartment built to resist the peak combustion rate of a fire, it would have to maintain its integrity for at least 20 minutes (which is the length of time at which the fire will burn at full intensity) in order for the thermal output of the fire to begin to decrease into the resolution phase of the blaze.

In contrast to these calculations for a putative modern compartment, the immense fuel load and restricted ventilation in relation to the great wall area, the Farmer's House produces a very different range of statistics:

$$1 \times \frac{13{,}347}{\sqrt{3 \times 177}} = 580.3 \text{ minutes (9.6 hours)}$$

Whereas a modern compartment would have to be engineered to resist a peak combustion rate of 20 minutes duration in order to maintain its integrity and contain the fire, the Farmer's House consists of such a concentration of fuel that it would require fire resistance sufficient to withstand over nine hours of fully developed combustion.

Law's Law is a means of quantifying structural fire and relating it to a modern analogue. It does not suggest a likely duration for a compartment fire and it is limited, in that it produces a static view of the fire, which is, in reality, a highly volatile situation. Gradual failure of the compartment, such as the collapse of the thatched roof, would serve to increase the value of A_w and correspondingly reduce the value of A_t. This would act to lessen the duration of the peak of combustion. Moreover, increasing ventilation within a compartment fire would allow the available fuel to burn at a greater rate.

Despite these limitations, Law's Law does succeed in quantifying a major difference in the fate of fires in buildings of modern and traditional fabrics. Modern compartment fires, where a reduced amount of potential fuel is available will tend to burn and resolve themselves whilst leaving the compartment standing; whereas fires in traditional structures generally have access to far higher quantities of fuel, which frequently feature in their construction. As a consequence, fires that involve a significant proportion of their interior will frequently result in structural collapse long before the fire resolves itself through a lack of available fuel. Depending on their proximity to one another, one would then expect the collapsed elements to continue burning or smouldering.

The photographs taken during the fire reveal the existence of two distinct compartment fires, separated by the heavy planked floor (Plates 3.1 and 3.2). By the time these photographs were taken, much of the structure above ground had already collapsed and many of the surviving charred timber members and wall boards had fallen outward away from the building. Were the Farmer's House constructed with a simple earth floor and no cellar, the remaining upstanding timber uprights would have been left to smoulder *in situ*, in a manner similar to other experimental structures (Harrison 2001).

The images reveal, however, that whilst the fire above ground appears to be all but extinguished through a dissipation of the remaining fuel, the cellar continued to burn fiercely. The heat from this second centre of burning is transmitted upwards towards the elements of the house that remain *in situ* above ground, largely by a process of convection. Unlike the superstructure, the confines of the cellar ensured that neither could the cellar lining fall away from the focus of the combustion, nor could the degree of ventilation increase prior to significant failure of the planked floor.

Images taken the following day reveal far more detail concerning the action of the burning above ground. To the sides of the building, mounds of charred thatch have fallen in line with the pitch of the roof, in far greater quantities than at the gable ends. The thatch reveals a characteristic stratigraphy of apparently unburnt or lightly scorched thatch low down against the ground, followed by a layer of thatch that was thoroughly charred, but still largely intact. Lastly, this charred layer is surmounted by powdery white-grey ash; the inflammable remains of thatch subject to total combustion.

This pattern of unburnt-charred-totally burnt from bottom to top suggests an early collapse of the roof fabric during the duration of the fire, either through the action of the hot gas layer within the compartment, or direct flame impingement where fire is carried up in the compartment by furnishings such as hangings. This collapse would appear to have occurred before that of any significant timbers. The timber lying N–S towards the E end of the N wall was overlying the surrounding thatch, although by the time of the excavation it would appear to be sitting directly on the ground. Elsewhere on the site, well-preserved deposits of charred thatch were located beneath collapsed timbers (Plate 3.24).

Much of the deposited thatch on the N and S sides of the building would appear to have continued to smoulder *in situ* following collapse. This smouldering was sufficient to combust the more volatile elements, such as hydrogen, but not to ignite the carbon, which is largely preserved as charred thatch. The thatch had been subject to further combustion, resulting in it being rendered to a white ash, where it had fallen particularly close to the outer floor joists that mark the original wall-line of the building (Plate 6.2).

It seems most likely that this top layer of material had been subject to total combustion as a result of the emission of heat by a process of radiation outwards from the fire. A compartment fire burning at peak development produces flames at temperatures in the region of 1000° Celsius. At a distance of a metre from the flame front, this would radiate thermal energy at a rate of 30kw/m^2 (Cooke and Ide 1985).

Plate 6.2 Photograph taken the morning after, looking S from the NW corner of the building down the remains of the W (gable-end) wall-line. The charred remains of the wall boards lie on the ground surface away from the building. Varying combustion of thatch reveals smouldering *in situ*

Given that this radiation has a configuration factor of 0.2/m, its power is reduced by a fifth for every metre it travels distant from the flame front. Radiation in the order of 12.5kw/m^2 is required to char timber and bring about pilot ignition (Cooke and Ide 1985); consequently, the radiation-derived combustion of the thatch, and also other collapsed timbers around the outside of the building, would be expected to continue to just over a metre from the edge of the fire. This calculation is certainly comparable to the extent of the burning evident in Plate 6.2, except where the radiation acting as the agent of combustion would appear to have been blocked by an obstacle.

The principle of radiative configuration can also be used in testing the model of whether a flameover reaction may have been responsible for the involvement of the entire above-ground structure in the fire. As discussed, a flameover reaction is generated by the ignition of a hot gas layer trapped within the ceiling of the compartment. Not only does this layer have to reach a temperature sufficient to cause its spontaneous ignition, but once alight, the gas layer must also be able to generate a level of thermal energy which, when radiated back down to ground level within the compartment, is sufficient to cause further ignition.

The ignition of cellulosic fuels, such as timber, by means of radiation requires *c*.20Kw/ m^2 of energy to be received at the fuel's surface. The benchmark figure that forms the basic requirements for flameover conditions was established by a series of experiments conducted by Waterman (1968; Drysdale 1998). Given that the configuration factor of 0.2/m for the dissipation of radiated thermal energy has been already established, the level of energy released from the hot gas layer can now be modelled (Fig. 6.2).

Even assuming a generous depth of hot gas layer of 2.00m from the crest of the roof, high given the combustible nature of the roof materials, forming a flame front *c*.3.00m from the planked floor, the thermal output from the flame front would still have to be in the region of 2500kw/m^2 in order to generate 20kw/m^2 at the level of the planked floor. Furthermore, the fire would even require an emissivity of *c*.1500kw/m^2 to generate the 12.5kw/m^2 at floor level to initiate scorching and smouldering. Both of these outputs are far in excess of the standard figure of emissivity of 150kw/m^2 for modern compartment fires (Cooke and Ide 1985, 271), and even exceeds the total thermal output of >1,400kw for an entire modern compartment fire at peak development (DeHaan 1997, 33).

By these calculations, even if the roof of the Farmer's House demonstrated sufficient integrity to allow the accumulation of a 2.00m deep layer of hot gases (which is unlikely), and subsequently tolerated being heated to temperatures in excess of 600° Celsius, which would allow it to combust in a flameover reaction, the height of the building is still too great to defeat the configuration factor of the radiated heat. An alternative model must be sought to explain the destruction of the Farmer's House, other than one akin to a modern compartment flameover.

Despite the difficulties in modelling caused by the geometry of the building, and the apparent lack of radiative energy available to strike the floor and surrounding ground, there remains clear evidence of extensive heating by

Structural Element	Description	Dimensions	Volume (m^3)
Cellar	Timber lining	14.00m x 1.20m x 0.06m	1.01
	Main posts	7.20m x 0.18m x 0.18m	0.23
	Half-round central posts	Π (0.10m) x 1.20m	0.04
	Central N–S joist	2.75m x 0.18m x 0.18m	0.09
	Central E–W joist	6.3m x 0.2m x 0.2m	0.25
	Outer joists, N/S sides	(6.3m x 0.2m x 0.2m) x2	0.50
	Outer joists, E/W sides	(5.2m x 0.2m x 0.2m) x2	0.42
	Joists for trapdoor	4.3m x 0.2m x 0.2m	0.17
	Joists for trapdoor	(1m x 0.2m x 0.2m) x2	0.08
Floor	Planks	5.00m x 6.825m x 0.1m	3.41
Total timber volume			**6.21**

Table 6.2 Approximate quantity of structural timber by mass. Note that the measurements for the posts excludes that part below ground, sealed within the postholes, and that part above ground; a mean of 0.05m has been taken for the thickness of the floor planks

radiation at low level. The rubification of the soil surrounding the cellar is highly unlikely to have been caused by any other mechanism of heat transfer. The soil is far too efficient an insulator to allow significant conduction, and the low level rules out the action of convection processes.

Far greater thermal energy would be available from the below-ground cellar to transmit to the surrounding ground than from the above-ground structure. Furthermore, the lined cellar would appear to represent a far more effective compartment for the development of a flameover reaction. Despite a lack of fuel at the earthen base of the cellar compartment, a collapse of structural material from above would be sufficient to introduce both a source of ignition and a significant quantity of fuel.

The cellar and its planked lid, i.e. the suspended floor, approximate a 6.21m^3 volume of available fuel (Table 6.2). Using a putative mass calculation of 800kg/m^3 gives a mass of 4,965kg of timber, for which DeHaan (1997) has supplied a statistic of potential energy of *c*.20Mj/kg. The total potential fuel supply available in the cellar, discounting the downward collapse of elements of the structure from above, is in the region of 99300Mj.

The peak rate of compartment fire burning of 150kw/m^2 must then be applied across the 15.00m^2 cellar floor, giving a total output of 2,250kw (2.25Mj per second). By arriving at an approximation for the burn rate per second, it is possible to estimate how long the cellar fire might burn at its maximum duration.

$$\frac{Total\ potential\ fuel\ available\ (Mj)}{Rate\ of\ burning\ (Mw)} = Maximum\ duration\ (Seconds)$$

$$\frac{99{,}300\ \text{Mj}}{2.25\ \text{Mw}} = 44{,}133\ \text{(Seconds)}$$

44,133 / 60 = 736 minutes of peak combustion

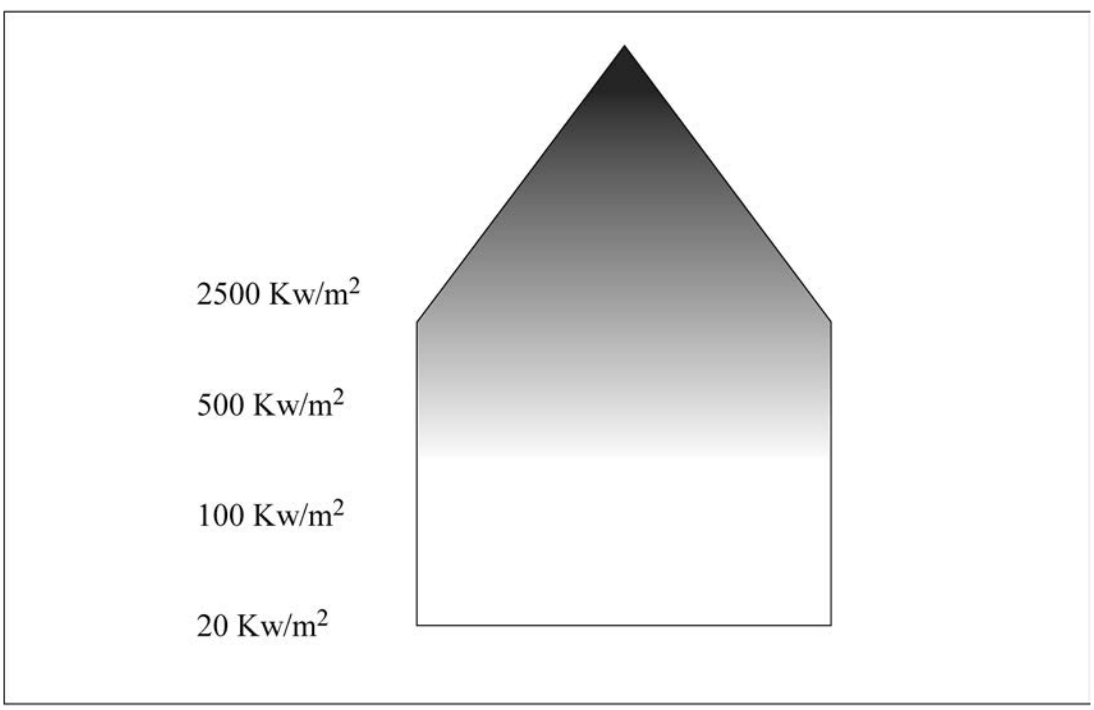


Figure 6.2 Schematic view through the building during combustion. Even with a two metre column of pyrolysis products burning, the fire would have to emit an impossible intensity of energy in order to generate the 20Kw/m at floor level required to initiate combustion there by radiation alone

Whilst the fire above ground would be largely incapable of causing thermal alteration to the surrounding ground, it can be demonstrated that a flameover fire developing and being sustained in the cellar is capable of producing the required temperature change in the earth at its edges.

As a theoretical total for the available potential fuel has already been suggested at *c*.99,300Mj, then a projection for the degree of thermal energy striking the cellar wall can be advanced:

99,300Mj total potential
Operating at 50% efficiency = 49,650Mj
Releasing 30% of its thermal energy through radiation = 14,895Mj

A restricted flow of oxygen into the cellar might be expected, given that any flow inwards from above would have to counter the flow of buoyant pyrolysis gases leaving the cellar by means of convection. The adjusted energy total striking the walls of the cellar can then be used to ascertain the degree of energy being absorbed by the earth. This is achieved through calculations based on the *specific heat* value of earth. Specific Heat has been described as the amount of energy (Kj) required to raise 1kg of a substance by 1° Celsius (DeHaan 1997). The statistic for modern brick; 0.8Kj/kg/°C, as supplied by DeHaan (1997), will have to serve as an analogue for earth. The mass of packed earth has been estimated as being 1522kg/m^3 (Anon 2008b). This gives the total mass of the first 0.20m of earth as being:

1,522 * 6.4 = 9740kg
Mass (kg/m^3) * Volume of earth in first 0.20m lining beyond the cellar (kg)

14,895,000Kj * 0.8 = 11,916,000
Radiant heat release (Mj) * Specific heat value

11,916,000 / 9,740 = 1,223
Calculated specific heat value/total mass of lining

By this model, a limited efficiency fire transmitting the vast majority of its energy by means of radiation could raise the face of the wall to a temperature of 1223° Celsius, to a depth of 0.20m behind the combustible timber lining of the cellar. This does not account for the dissipation of some radiated energy deeper into the soil, nor for the addition of more fuel from above the cellar. Furthermore, it cannot factor into the calculation the effect that the other heat processes — convection and conduction — may have had on the earth, other than to suggest that their role in this heating would have been a far lesser one.

Clearly, such a model of combustion dynamics is not to be held up as a demonstration of a possible course of cause and development of the fire in its own right. It serves to provide an approximate means of quantifying the major factors in a structural fire that can suggest the limits of possibility for the fire. The examination of fire artefacts may shed more specific information.

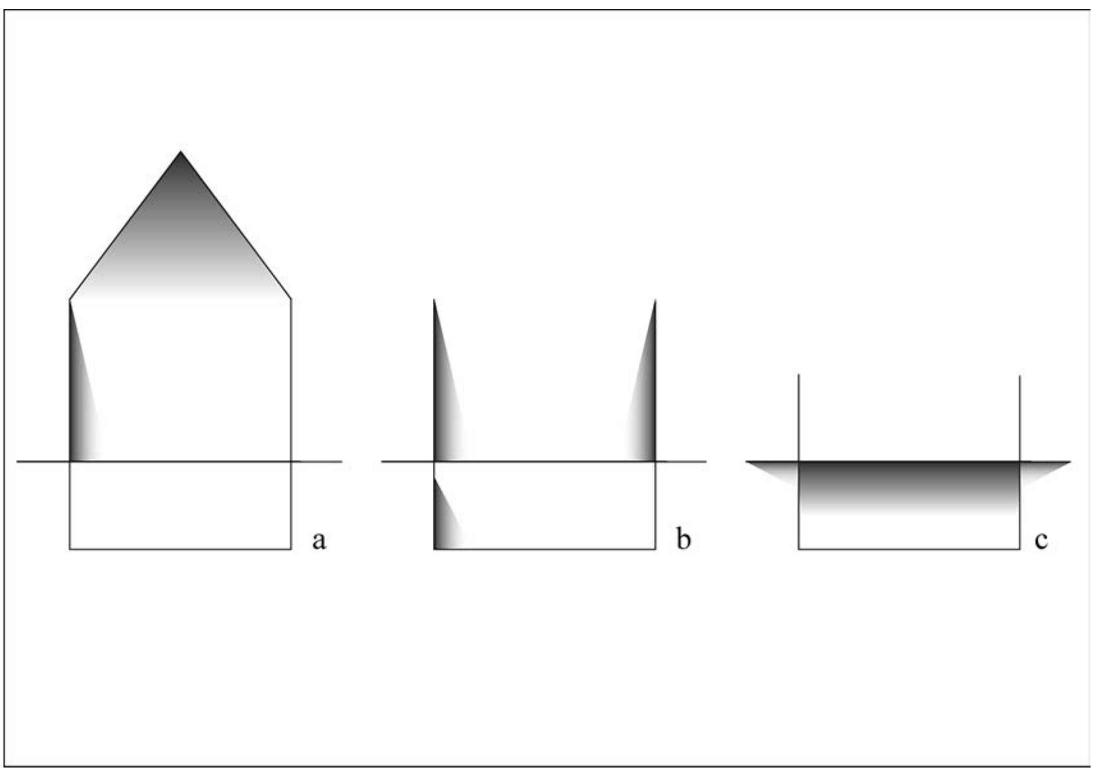


Figure 6.3 Schematic views through the building to show the suggested pattern of destruction and two distinct stages of burning

a) A fire begins in the main living space of the building, on top of the suspended floor. Such a fire would rapidly entrain up a nearby wall and reach the easily combustible interior of the thatch roof. The ceiling area would thus be engulfed before the level of the floorboards was compromised
b) The thatched roof collapses as the twine fixings are burned through. Partially burnt and smouldering thatch is deposited along the sides of the building. The interior of the structure now burns like an open fire, with much of the intensity caused by ventilation restrictions lost. The burning at floor level ultimately compromises the planked floor, initiating a second phase of burning beneath it
c) The lining of the cellar area is such that it burns as a reduced-atmosphere fire for an extended period. Unlike the first phase of burning, the cellar lacks any easy means of heat release, resulting in an especially intense blaze, which is sufficient to cause extensive damage to all but the lowest cellar timbers, as well as discolouring the surrounding soil

The physical constraints of available fuel and ventilation, in conjunction with the insights provided by the photographs documenting both the construction as well as destruction of the building, strongly suggest an unusual two-stage fire as being the most likely cause of destruction (Fig. 6.3). This unusual pattern would seem to be dependent on the nature of the SFB construction.

A fire beginning at the level of the suspended floor inside the building would rapidly spread in the manner of an open combustion, particularly given the spacious, largely non-compartmentalized interior of the building. The most easily ignited internal fixtures and fittings would quickly become involved, promoting an extremely rapid upwards development of large flames. Such flaming combustion would rapidly spread to involve the combustible roof materials and, particularly against the N and south walls, such fire would be expected to impinge directly upon the roof.

The roof fixings would have been exposed to an internal fire, as they were secured to the exposed rafters on the underside of the roof (Plate 2.14). It is likely that these would have burnt through in the initial phase of the fire, long before the hot pyrolysis gases had had an opportunity to gather in the roof space prior to a flameover-type reaction. Consequently, much of the material forming the roof would be expected to collapse to the ground along the line of its pitch, before much burning of the thatch. Such a collapse would cause the type of *in situ* burning exhibited in the post-fire photographs.

The venting of the roof space would then mark the last chance for the upper structure to develop in the manner of a compartment fire. With the collapse of the roof material, it is likely that the building never developed an opportunity to behave in the manner of a ventilation-controlled fire. The fuel-dominated and well-vented fire that developed in its stead was one that most likely brought about mechanical destruction concentrated on those areas of the timber structure where the surface area was at its greatest in relation to its mass, such as at complex joints, corners, and the terminal ends of beams.

It has been suggested that the observed propensity for large upright timbers to fall outward, away from the fire, might be due to the relative change in the distribution of mass, following partial combustion (Harrison 2001). Prolonged exposure to fire and consequent smouldering of the inner face of the timbers might cause them to grow lighter and favour tipping away, in the direction of the denser protected outer face. This pattern of splaying outwards is clearly evident in the long boards of the E and W gable walls of the Farmer's House, where distance from the fire has preserved much of the outer face of the timbers relatively intact.

At some point during the course of the fire, a collapse of the floor boards is most likely to have introduced an ignition source into the enclosed and relatively oxygen-depleted environment of the cellar. However, unlike the superstructure, the combustible elements of the cellar were incapable of outward collapse. Furthermore, while the superstructure lacked the necessary levels of potential energy and the means to direct them towards the ground, the combustion of the cellar lining prior to its inward collapse was well positioned to deliver a far greater degree of temperature change to the surrounding earth walls of the cellar pit.

The hypothetical modelling of the combustion of the Farmer's House has suggested that the most likely way of combining both the survival of relatively fragile elements, such as the roof thatch, and the significant temperature alteration to the surrounding earth is via an unusual fire featuring two separate and identifiable patterns of combustion (Fig. 6.3). This fire would be brought about by the constraints of the building's material and geometry, rather than because of the actions of any potential fire setter. The first fire is a relatively rapid and low-intensity flaming combustion, quickly destroying the roof and scattering upstanding timber elements through mechanical destruction at weak flammable points of the structure. The second blaze is a contained and far more intense cellar fire, where low oxygen levels might limit extensive spread of flame, ensuring a significant degree of thermal energy is transmitted upwards and outwards.

Such a pattern of burning would be remarkable within a forensic context, but is to be regarded as even more so within an archaeological context, where flammable building materials and relatively low levels of structural integrity tend to promote rapid and simplistic flaming combustion over true compartment fires. Most notably, this two-stage model might be applied to the remains of structural fires of SFBs in the archaeological record, in an attempt to ascertain both whether the same pattern is indicated, and potentially to comment on the veracity of the fuel levels and geometry of the Farmer's House, with a suspended rather than sunken floor, as an accurate reconstruction.

The hypothesis of a two-stage fire is clearly a notional one, based on the principles of fire engineering and supported by the calculations generated by measurement and estimation of properties of the construction. These calculations appear to match the patterns of destruction presented in the photographs of the building following the extinction of the fire. The application of the techniques of fire investigation on the surviving fire artefacts (i.e. the archaeological remains), detailed in the following section, may be of use in both testing this hypothesis further, as well as in commenting on the origin and development of the blaze within the building.

V. Investigating fire indicators in the Farmer's House

A hypothesis for fire development within the Farmer's House has been established, in the form of a model based on the principles of fire engineering. Based on this model, the evidence of the fire itself can be examined. Forensic fire investigators utilise the characteristic traces of destruction and preservation that are associated with a structural burning. These traces may assist in suggesting a point of origin for the fire within the compartment, the spread of fire, the subsequent pattern of destruction, the general character of the fire, the nature of fuel consumption and the ventilation available to the fire.

Whilst a range of investigative techniques appear to be suitable for use on the Farmer's House, these divide into two distinct categories of examination: damage-intensity indicators and directional indicators.

Damage-intensity indicators specifically target localised areas of destruction, which have been subject to exceptionally intense degrees of burning. Examination of these areas allows the investigator to decide whether the increased intensity of burning is due to the type or amounts of fuel available, greater ventilation driving more efficient combustion, or a more sustained episode of burning suggesting a potential point of origin for the fire.

Directional indicators, by contrast, are a range of characteristics, the orientation of which may provide information regarding the original location of the fire and the subsequent process of its development. Smoke staining and scorching to walls and fixtures, and also differential burning in a range of structural timbers, can be used as indicators of fire direction (DeHaan 1997).

Table 6.3 lists those methods of investigation that would seem to apply themselves most readily to the Farmer's House. These techniques are designed to provide a series of overlays of information regarding the fire, the collective conclusions of which may assist in providing a hypothesis that can encompass fire origin, development and eventual structural collapse. As is frequently stated in the forensic literature, none of these techniques should be relied upon to the exclusion of the others (DeHaan 1997).

Damage intensity methods	*Directional methods*
Char depth analysis	Qualitative observation of burn patterns
Depth/extent of soil discolouration	Observation of smoke record characteristics
Collapse	Stratigraphic analysis
Temperature	Analysis

Table 6.3 Suitable methods of analysis for the Farmer's House

The nature of the timber building and its total collapse does pose a range of problems rarely faced in contemporary forensic fire investigation, especially in a UK context. Modern brick built houses will generally survive fires structurally intact, even when the interior has been subject to very intense burning. Such structures provide an upstanding frame within which directional indicators can be located and understood. By contrast, the collapse of the Farmer's House makes such understanding far more problematic and challenging, and reliant on the identification of timber elements of construction recovered out of their original context. Whilst this is unlikely to preclude any conclusions regarding fire direction and development within the building, it is a significant limitation that the Farmer's House shares with the vast majority of structures in the archaeological record.

Char depth analysis relies upon the close observation of damage to timber elements of the structure, in order to identify both areas of intense burning and relative protection. In the past, fire investigators have attempted to use rates of charring in timber to produce standardised timings of combustion to establish the duration that a fire might have burned for. Research on rates of charring has since demonstrated that they are in fact affected by a wide range of factors, such as species of timber, or the mass to surface area ratio of the timber. Therefore, claims for fire duration from timber char are, at best, unreliable.

Conclusions on the duration of fires based on the depth of charring to timber subject to burning has previously relied upon an observation that the mean rate of char depth development is approximately 0.6mm per minute of combustion. This work has since been regarded as somewhat simplistic in relation to a real fire environment (Cooke and Ide 1985). The discussion of complicating factors such as wood species, mass to surface area ratio and presence or absence of paints or varnishes has highlighted the difficulties inherent in relying on a range of assorted burnt timber articles in attempting to establish absolute degrees of charring. However, where a relatively uniform type of timber has been utilised throughout the construction of a building, then variations in its combustion can be recorded and used in assessing relative degrees of destruction.

The Farmer's House is largely standardised in terms of its elements of construction. Close observation of surviving timber members reveals a range of standard elements (wall boards, joists, etc.), which exhibit similar proportions, appear to originate from a similar source, and are cut in relation to their grain in very similar ways. Consequently, a range of char measurements could be taken to make initial observations regarding the general intensity of the fire.

The outer floor joists that surround the pit of the Farmer's House make one of the most informative statements about the localised differences in the observed depth of charring. These timbers were of relatively uniform composition, being square-cut lengths of oak, some 0.18m in section. During their recording and removal, it emerged that they had been subject to some degree of rot on their lower face, but otherwise they appeared to have been in relatively good condition before the fire. Their position on the ground makes them especially useful as static markers through the blaze, whereas other elements of the structure were subject to collapse and scattering.

Despite their appearance following the fire as eight short lengths of timber, two on each side of the building (Plate 3.7), the outer joists were formed from four long lengths of timber, each running the entire length of one side of the building (Plate 2.6; Chapter 2). These were joined to each other at the ends, by means of half-faced lap joints, securing the structure at the corners. In addition, there was also a central E–W floor joist, half-lapped over the two end joists.

The increase in surface area and available ventilation around the edges of these joints is most likely to be the cause behind their preferential burning during the fire, hence the complete combustion at all four corners of the building. In addition to the corners, there were a number of other sites along these joists that have been subject to similar levels of destruction. The centre of the E and W outer floor joists, where the central supporting joist ran over the cellar pit, and the middle of the N floor joist, which had joints to take additional joists for the trapdoor. By contrast, the mortises for the door-posts which survived the fire were located at the base of the largest ventilating area built into the structure, and as such would have been subjected to less heating than other elements. Whilst it stood, the doorway would have vented hot combustion gases from the top, and drawn in cold air from the bottom.

In addition to these areas of complete combustion, three other sites along the outer joists appear to have been subjected to uncharacteristically intense burning. On the N side of the building, a large section of the outer joist is absent and has been destroyed. While this might be partially explained by the two additional joints in this area (to take the two N–S joists which supported the cellar trapdoor; Chapter 2 and Plate 2.6), the effect of these joints in altering the surface area to mass ratio for the fuel may have been exacerbated by an apparent underlying animal burrow at this location (Plate 3.8). The burrow would have supplied oxygen to the reduced atmosphere burning of the cellar fire, and would have acted as a vent for the hot combustion gases given off.

Along the S side of the building, at the W end of the outer floor joist, a long section of the joist had been subject to complete combustion. This area would appear to begin at the W door-post and extend close to the SW corner of the building. Here there appears to be little or no evidence for either extensive ventilation beneath the joist, nor for a particularly high concentration of fuel. In fact this pattern of burning would seem to be an artefact of later smouldering following the fire, as the timber appears intact in the photographs taken immediately following the fire.

The third area of complete combustion of the outer joists, not easily understood by means of the modifications made at construction, was at the SE corner of the building. Photographs taken before the fire do not suggest any extra ventilation purposefully designed into the structure at this point, nor does it appear to have featured an increased local fuel load. Complete combustion may have been due to an increase in ventilation brought about by an accident of landform rather than design; the ground on which the building was

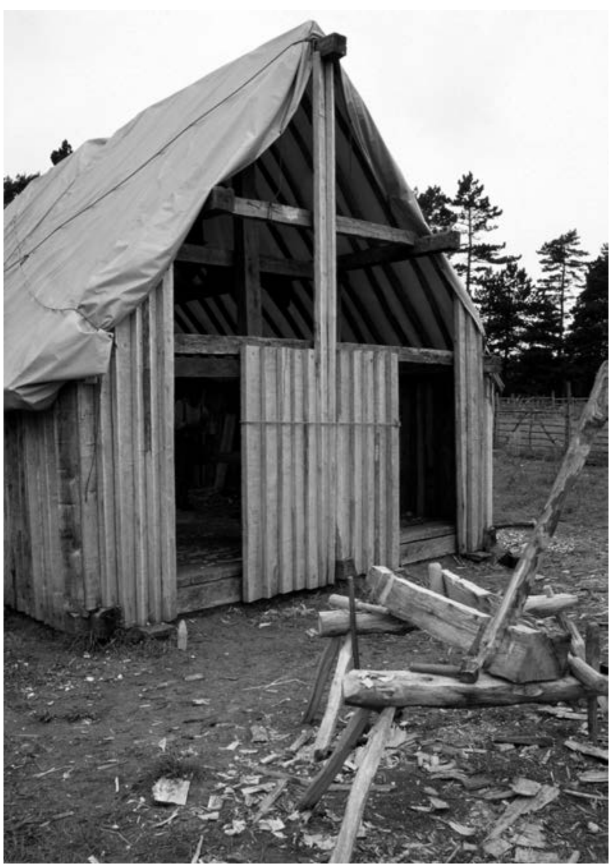


Plate 6.3 The E gable-end of the building during the fitting of the wall boards, with a vented area (i.e. slight gap) apparent beneath outer joist (viewed from the SE)

constructed sloped very gently S and E, with the SE corner the lowest point. Photographs of the exterior taken on completion of the Farmer's House suggest a void *c*.0.05m high between the bottom of the outer joist and the ground surface along this section of the wall (Plate 6.3; see also Plate 2.12). Unfortunately, due to limited photographic resources from the construction of the Farmer's House, it is impossible to state categorically that a similar void had not been present elsewhere along the base of the structure.

Taken as a whole, the evidence preserved in the remains of the outer joists suggests a greater low level intensity to the fire occurring at the S (front) side of the building. By contrast, the areas of intense burning to the N (rear) side are more easily explained by the physical effects of the animal burrow on the behaviour of the fire.

In a similar manner to the depth of charring observed in structural timbers, the degree of temperature-related discolouration observed in soil adjacent to the building might also provide an indication of the intensity of burning at particular locations around the building. The unusual depth of burning in relation to ground level caused by the continuation of combustion into the timber-lined cellar, forming a second phase of fire development, would appear to have been the cause of significant levels of discolouration and temperature alteration. This is particularly likely, given that an animal burrow behind the cellar lining appears to have acted to vent hot gases.

A correlation of observations between levels of char along the outer floor joist, together with temperature-derived alterations in soil colour, may point to an anomaly of burning within the building. Such an anomaly may have been the result of a concentration of fuel at that location; a possible origin point of the fire or an early collapse in the structure's integrity, which may have brought about a subsequent release of heat in a specific location. A fire seat may have burned locally for some time before spreading further and involving the entire building.

In his examination of temperature-related alterations to the physical properties of sandstone, Murley (2003) noted that the change in colour from yellow to red-pink was due to changes in ferrous salts; especially the decomposition of limonite in limestones at 300°C (Chakrabati *et al*. 1996). In sandstones, a change from brown to reddish-brown appears to correspond with the dehydration of iron compounds at temperatures between 250–400° Celsius. Similar changes might be expected in highly compacted sandy soils, such as those at West Stow. The startling colour changes notably concentrated directly outside the outer joists may point to the fact that similar ferrous oxide minerals form a component of the soil.

The discolouration of soil around the Farmer's House displayed a sharp distinction from the apparently unaltered soil further removed from the fire, rather than a steady fall off of alteration (Plate 3.23). Hajpál (2002) has noted similarly sharp boundaries in sandstones subject to heating above *c*.200–300° Celsius. She notes that the depth of discolouration was frequently shallow, at *c*.0.02m, but that a maximum depth of 0.05–0.08m of discoloured material was observed, and that this appeared to relate to more intense areas of combustion, caused by concentration in fuel load.

Hajpál continued to observe and note further complications to the pattern of temperature-related discolouration in the sandstones of historical monuments. Where stones contained traces of organic carbonaceous material and surface temperatures continued to rise, a grey char developed over the top of the reddening at *c*.500° Celsius. At still higher temperatures, this carbonaceous char was subject to total combustion, again revealing the distinctly rubified surface of the stone.

The soil surrounding the remains of the Farmer's House exhibited a similar range of traces of discolouration as observed and discussed by Hajpál. In areas where combustion had been sufficiently intense to result in the complete combustion of the outer joists, the carbonaceous elements of the ground surface appear to have been similarly consumed, leaving a red-pink outline, similar in dimensions to the origin extent of the joist on the ground (Plate 3.10).

Beyond the direct contact of the outer joists, the degree of discolouration appears to be sharply defined, quickly falling away to a grey-yellow colour. Excavations beneath the thin upper surface of char and soil revealed an extension of the discolouration beyond the confines of the compartment. This discolouration varied sharply between black charring and red-pink discolouration. In places these areas of discolouration appear to relate to sections of complete joist combustion, and may in those instances be due to a temperature increase caused by radiation directly from the burning compartment. However, in other cases it appeared where the burning had not been sufficient to combust the adjacent section of timber.

The continuation of this pattern outside the structure regardless of the state of destruction of the joists suggests that the pattern was caused by a means of heating other than direct radiation from the structure. Reference to the photographs taken during the fire (Plates 3.1 and 3.2) suggests that much of the discolouration may relate to the continuing combustion of other structural fuels falling outside and away from the footprint of the building, such as the smouldering thatch, which is concentrated along the N and S sides of the building.

This colour change might be subject to further checking by the application of geochemical and geomagnetic analysis across the area. If the local sandy soil reacts in a similar manner to the sandstones examined by Murley (2003) and Hajpál (2002), then such analysis would be expected to reveal an increase in the magnetic susceptibility, and an associated concentration of ferrous components.

In addition to the gross observation of fire intensity reflected in the degree of charring to structural timbers and the discolouration of adjacent soil, the manner and pattern of collapse of the building might also be instrumental in ascertaining which elements of the structure were the first to collapse. If the first areas to collapse can be identified, they may relate to inherent weaknesses in the structure but they might point to potential seats of fire, where low-level burning has succeeded in compromising the integrity of the structure before the involvement of the whole compartment.

Where concentrations of building material fell around the building, especially along its S and N sides, some conclusions might be reached regarding which elements of the structure were first liable to collapse through burning. Additionally, whilst the stratigraphy of collapse cannot be assessed in terms of duration, the occurrence of *in situ* smouldering of structural elements following collapse is highly suggestive of very rapid deposition, which caused a concentration of locally available fuel for the continued smouldering.

The series of photographs taken during the fire, and the continued charring observed in some of the larger collapsed timber elements suggest that a significant proportion of the building collapsed during or immediately following the fire, rather than long enough afterwards to allow it to cool whilst still standing. By contrast, other elements of the structure, such as the slats from the window shutter, appear to have been thrown away from the blaze early enough in the development phase of the fire that they exhibit only superficial scorching. A third group of structural elements appear to have been extensively damaged by fire, yet do not demonstrate evidence to suggest further smouldering and charring once they have been subject to collapse. This suggests they burned fiercely while in their original position in the building, but only fell to the ground when they had cooled sufficiently so that they did not continue to combust independently.

The ground to the W of the Farmer's House reveals a range of these patterns; a group of wall boards fell outwards from the W wall, burning through at a very low elevation. The topmost 2.00m of the length of the longest board survived in a single piece, having fallen to the ground. Closer to the W wall these boards were reduced to a diffuse spread of charcoal — those constituent elements more volatile than the carbon content had been subject to combustion.

These boards were relatively well preserved on the lowest (outer) sides, suggesting that they may have collapsed at a relatively early stage in the fire, and that they potentially fell as a unit. If one or more of these boards had fallen independently during the peak phase of the fire, the venting of flames and hot gases through the holes in the wall would have resulted in a greater degree of overall charring and a notably more intense degree of fire damage would have been caused to those boards left standing for longer. Similarly, these wall boards exhibited the angled ends cut to match the eaves of the roof at the gable ends of the building. If any wall boards had remained in position after others had fallen early on, these cut ends would have been expected to suffer particularly severe damage due to their height and the buoyant nature of flames and hot gases.

At the W end of the building, the division between the area of intense charring to the lower part of the collapsed wall boards closest to the wall-line, and the greater preservation of their upper ends that fell further away from the wall-line, is sharply defined by a line of destruction running from the NW corner of the building in a SW direction (Plate 6.4). The E end of the building seems to reveal a very similar picture, with lengths of wall board surviving at a distance from the E wall, and clearly visible angled ends at the top of these boards. Closer to the wall-line, the composition of these charred boards again breaks down into a diffuse spread of charcoal representative of more complete combustion following the collapse of the wall. Again, a linear distinction appears to define these two areas, with this line running from the SE corner in a NE direction.

These two lines of destruction at the ends of the Farmer's House appear to share a parallel relationship, which suggests the possibility that they share a common origin, and may represent a distinct form of structural collapse. If the top ridge beam of the structure were subject to mechanical stress brought about or exacerbated by the fire, it may have been subject to a shearing effect, causing the upper section of the building to twist, forcing out end tie beams at an angle from the wall-line.

If the wall boards were still standing when such an effect took place, the shearing action might account for their sudden collapse as a group, their aligned collapse away from the building. The base of the wall boards remained in place, pegged to the outer side of the outer joists. This hypothesis, of a shearing effect, would also provide a possible explanation for the outward collapse of the end boards, whilst a similar effect does not seem to have befallen the walls along the N and S sides of the building.

The greater angle of collapse at the SW, and perhaps also at the NE corners might indicate an inherently greater degree of structural stress being concentrated at these points, which any destructive fire within the structure might cause to initiate a collapse. Alternatively, if the mechanical stresses across the structure were equal, the greater angle might indicate a seat of fire, with its associated destruction early in the development of the fire.

The final damage-related indicator of fire development is the analysis of available temperature benchmarks within the structure. The close photographic recording of the fire assists with the plotting of the location of potentially informative materials within the building, as well as in commenting on the temperature suggested by any observed degradation.

A limitation to this technique is that many of the items of interest are soft or portable furnishings by nature rather than structural fixings, and as such, would be particularly liable to collapse during an early stage of the fire. In more conventional structures lacking cellars, these might be buried by later debris and thus protected from a significant proportion of the potential heat damage available elsewhere in the structure (Cooke and Ide 1985, 128). In the context of an archaeological investigation, such potential protection should be evident in the examination of the stratigraphy of related contexts. In the case of the Farmer's House, the second more destructive compartment fire largely precludes the potential offered by this otherwise useful evidence.

In addition to the information provided by models of energy release relating to potential fuel arrangements within the compartment, or to possible patterns of structural collapse, the wide range of furnishings that were contained within the Farmer's House, and their various reactions to the fire, provide a range of temperature indicators relating to the fire inside the building. However, a further limitation is that indicated temperatures cannot be readily tied to specific areas of the interior, due to the movement of items during their deposition within the fire. Items recorded as falling to the floor beneath the spot where they were located before the fire, might be regarded as relatively static, and informative about the intensity of the fire in a particular part of the building.

Two distinct temperature benchmarks are associated with combustible substances; the first is the flash point: the temperature at which sufficient volatile chemicals are liberated from a compound fuel that they ignite at the application of a naked flame (Wharry and Hirst 1974). The second temperature benchmark is the auto-ignition point, which marks the temperature at which the liberated fuel gases are sufficiently excited that they spontaneously combust without the application of a flame source (Cooke and Ide 1985). Most fuels exhibit a flash point which is considerably lower that the temperature required for auto-ignition.

Plate 6.4 The *in situ* remains of the outer joists (viewed from W end of building) following clearance of the remains that collapsed outwards around the building, with linear patterns of destruction marked with white lines. The heat-shadowing along the S side of the building, below the position of the (destroyed) S joist is particularly clear

Construction timber utilised in a modern context has been noted as having an auto-ignition temperature of 660ºF (*c*.345º Celsius; Redsicker and O'Connor 1997). Although the fire in the Farmer's House clearly rose far in excess of this figure, it serves to illustrate the fact that temperature represents a measure of the heat of an element, rather than the amount of thermal energy it holds. As such, it tells only half the story regarding the intensity of combustion within a structure.

More informative benchmarks might be provided by elements of the structure, predominantly metals, known to respond to higher temperatures (DeHaan 1997, 173). The fire extinguisher located in the SW corner of the structure is a useful case in point (Plate 3.9). The water tank is comprised of steel which, whilst subject to oxidation and discolouration, does not exhibit any great deformation other than at one point, where the tubular steel body appears to join the domed top at a welded line (Plate 3.37). Similar patterns of structural failure have been noted by Cooke and Ide (1985, 114) in relation to examinations of failed gas cylinders; they noted that the face of the cylinder subject to distortion is that generally exposed to the majority of the fire's energy. Whilst the melting point of steel has been recorded in the range 2350–2675ºF (*c*.1275–1454º Celsius, Redsicker and O'Connor 1997), the mechanical strength of mild and high strength steel might be compromised by as much as 80% when heated to 700º Celsius (Institution of Fire Engineers 1989).

The top of the fire extinguisher comprised a steel squeeze handle held at the top of the steel cylinder dome by a brass retaining couple. This couple was not in evidence on excavation. The steel handle had apparently fallen a short distance S of the cylinder, and a quantity of molten brass had re-solidified as a series of amorphous lumps in the same area. Being the product of a copper and tin alloy, the melting point of brass is dependent upon its exact composition. A range of 875–980º Celsius has been indicated as likely (DeHaan 1997, 173). Taken as a whole, the remains of the fire extinguisher suggest a local temperature between 900–1200º Celsius, given the slight deformation of the steel cylinder and the total melting of the brass elements. This level of temperature is comparable to the intensity frequently found in modern compartment fires.

The other issue raised by the extinguisher is its explosive potential within the fire, given the failure of its retaining couple. The apparent ejection of the window slats from a position in the S wall of the building suggests that they may have been deposited by a force capable of throwing them some distance from the fire and perhaps by the explosive effect of the extinguisher, which was below the window (Fig. 3.7).

A container of water heated to boiling point sustains a pressure of 1.3 times that of liquid water at standard room temperature, and as such might be capable of causing an explosion known in fire science as a BLEVE (boiling liquid expanding vapour explosion), of sufficient force to damage the wooden window shutters. However, the nature of the extinguisher, its apparent damage and the location of the handle close to the cylinder, and also the geometry of the SW corner of the building suggest that explosive decompression is an unlikely cause for the observed pattern of damage.

Most pressurised cylinders feature a pressure release valve, which allows for safe decompression prior to the rupturing of the tank (Cooke and Ide 1985). Furthermore, where BLEVEs do occur, they tend to do so as a result of a catastrophic breach in the lining of a cylinder, causing fragments of metal to detach and the cylinder to grossly deform. Whilst some minor changes in shape are noted in this particular cylinder, it does not come close to matching the level of damage apparent in some of the contemporary forensic examples (Cooke and Ide 1985, pl. 11d).

Given the lack of perforation to the body of the cylinder, any explosion would be reliant upon the failure of the brass couple at the neck of the extinguisher. As has already been indicated, the melting point of brass at a suggested minimum temperature of 875º Celsius would predicate a developed fire capable of significant thermal output. Even if such a development was local to the SW corner of the building, it would be reasonable to assume that such a fierce blaze would also cause significant damage to the window shutters whilst they remained *in situ* over the extinguisher. While some portion of the shutter slats appear to exhibit a deeper char, they are for the most part lightly scorched. This suggests that they were deposited at a distance from the building at a relatively early stage in the fire's development.

It seems reasonable to conclude that the deposition of the window shutters occurred during the development stage of the fire, prior to the failure of the fire extinguisher; it is, therefore, not related to the failure of the extinguisher. The integrity of the extinguisher would have been maintained until much later, at the peak of thermal release. The internal pressure of the cylinder ultimately rose to an extent that the release vale was triggered, and this would have been in a controlled, if forceful, discharge of steam, rather than in the manner of an explosion. Following this decompression, the lack of a reserve of water in which to sink the rising thermal energy would cause the extinguisher to reach still higher temperatures, at which point the brass elements would melt and the steel tank deform.

The geomagnetic properties of the Farmer's House (Figs 6.4–6.5)

Across the site of the Farmer's House, the colour change of the sand-rich soil remained relatively shallow, on average only penetrating some 0.02m in depth. Where the outer joists had been completely destroyed, the ground surface was burned bright orange and marked their original location. However, even where the burning was most intense, the depth of burnt soil was incredibly shallow and less than 0.05m deep where the outer joists had been destroyed. The depth of soil discolouration within the internal area of the building, on the ground surface, was also incredibly shallow. The ground remained unburnt below the surviving joist sections.

Outside the Farmer's House, the soil discolouration rapidly fell away from the wall-line to a grey-yellow colour, although in places the discolouration was evident at a much greater distance from the building. Reference to the photographs taken during the fire suggests that these discrete areas of discolouration relate to the continuing combustion of structural fuels, principally in the form of wall boards that fell outwards and away from the edge of the building.

In sandstones, colour change from brown to reddish-brown corresponds with a dehydration of iron compounds at temperatures between 250–400°C (Chakrabati *et al.*

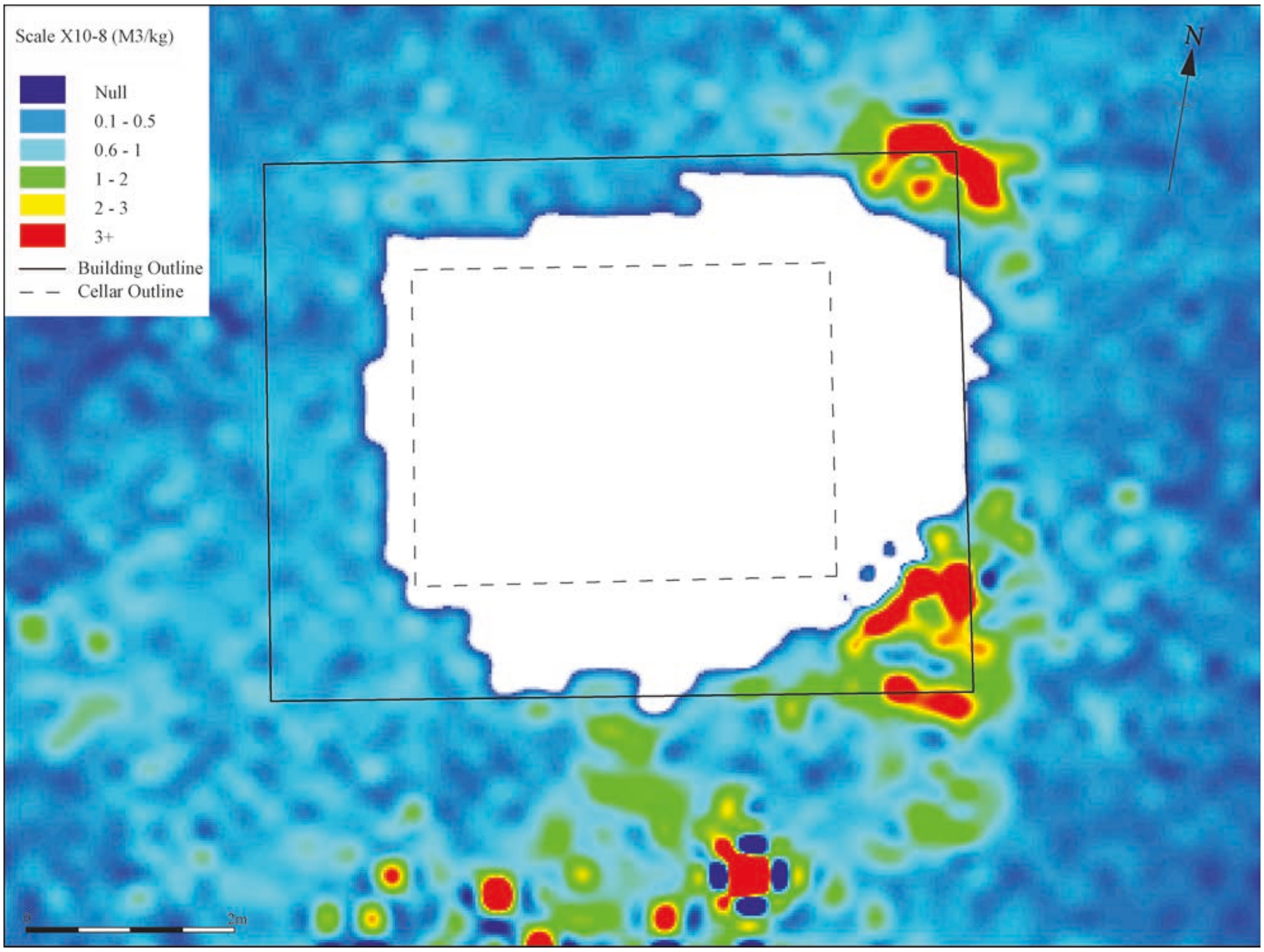


Figure 6.4 Graphical representation of magnetic susceptibility data at the site of the Farmer's House undertaken on the ground surface within and outside the wall-line (but not within the cellar pit) after the clearance of the surface remains in July 2006

1996). A discolouration has also been observed in sandstones subjected to heating in excess of *c*.200–300°C (Hajpál 2002). Although no controlled experiments have been undertaken, a similar change might be expected in compacted, sand-rich soils like those at West Stow. Recent research on the effects of burning on soils have concentrated on the release of carbon brought about by pyrolysis of the incipient organic content (Gonzalez-Perez *et al*. 2004; Bird *et al*. 2000), or else have utilised colour change brought about by burning as an indicator of fire severity (Ketterings and Bigham 2000).

As an indicator of burning, however, colour change is questionable. Its interpretation is subjective, particularly where discolouration is subtle. In addition, soil colour may vary for reasons other than alteration by temperature elevation. Previous research has also noted that the greatest areas of discolouration do not necessarily correlate with the highest degree of magnetic susceptibility elevation (Canti and Linford 2000).

Geomagnetic analysis can reveal increasing intensities of magnetic susceptibility where colour alteration is the result of dehydration and concentration of ferrous soil components caused by burning. Mullins (1977) discussed the means by which soils might be subject to magnetic enhancement through mineralogical change. One of the most important catalysts for conversion is burning, or more appropriately, the elevation of temperature in close proximity to organic material. Such conditions result in the conversion of antiferromagnetic minerals to ferrimagnetic ones. While the proportion of iron content in converted minerals remains broadly constant, the degree of magnetic susceptibility differs by several orders of intensity (Dearing 1999, 55).

The relationship between increased χlf measurements (low frequency magnetic susceptibility) and episodes of burning over ferruginous soils has been explicitly explored in relation to the fills of Anglo-Saxon *Grubenhäuser* excavated at West Heslerton, North Yorkshire (Macphail *et al*. 2006, 6). Following on from this research, and in an attempt to counter the reported lack of coordination between archaeological excavation and the specialist application of geomagnetic analyses (Macphail and Cruise 2001, 242), the site of the Farmer's House was subjected to geomagnetic survey.

A magnetic susceptibility survey was conducted at 0.20m intervals across the site of the Farmer's House in July 2006, on the ground surface within the footprint and beyond the farthest collapsed remains of the building. The cellar pit, excavated in 2005, had suffered further side collapse and erosion and was not suitable for survey. Some plant recolonisation had also taken place on the surface around the pit during the intervening year.

The surface had been reduced by several centimetres in the previous summer when the burnt remains were recorded and lifted. Ideally, the entire ground surface around the building could have been reduced in

0.05–0.10m spits and re-sampled each time to investigate the effect of magnetic susceptibility with depth. Likewise, the base of the cellar could have been sampled (during excavation) for comparison with the ground surface. However, this work was beyond the means of the current project and it is possibly an area for future research elsewhere.

The detailed survey revealed a marked distinction between the background magnetic susceptibility of the site, and elevated signatures due to the temperature-related modification of the mineral content of surface soils, with general background levels between 0.1 and 1 10-8 m^3/kg and elevated χlf (low frequency magnetic susceptibility) readings of between 1 and 10 10-8 m^3/kg.

The values of magnetic susceptibility formed significant patterns with elevated readings that cluster close to the edge of the pit. Three of these clusters occur at NE, SE and SW corners of the original building, starting at the top edge of the pit but remaining elevated to *c*.0.40 back towards the corners of the original building (Fig. 6.4). While that in the SW corner was a relatively minor elevation, the two in the NE and SE corners indicate significantly higher levels, peaking at *c*.8.85 and 8.39 10-8 m^3/kg respectively.

The patterns of magnetic elevation along the S side of the building reflect the position of the door and window. A cone of enhanced readings originate from around the centre of the S edge of the pit, extending outwards to the S for *c*.2.00m, where the base of this cone was *c*.4.00m across. Radiation emitted from the building while the walls were still standing might bring about this pattern. The open doorway would have allowed an unobstructed passage of heat to strike the ground almost immediately, extending outwards from the doorway in a roughly 90º angle. By contrast, the window was set a metre above the floor, which could act as a timber shield that served to protect the ground directly beneath it (i.e. directly outside the building) from radiant heating. The resulting pattern evident in Fig. 6.5 would be expected if the window and door spaces had been maintained through the peak of combustion.

There are two other minor points of thermal elevation, indicated by enhanced values of magnetic susceptibility along the centre of the pit on a N–S axis. These appear to match the location of uprights that ran from the base of the pit to the apex of the roof. Again, this suggests that at least part of the structure remained intact during the fire. Areas of magnetic elevation around the NE and SE corners of the pit suggest the transmission of significant amounts of thermal energy to the surrounding ground surface. The timbers at these corners collapsed during the peak of combustion (Plates 3.1 and 3.2). The inner surfaces of these timbers would have been fully involved in the fire and their overlapping layout would have allowed the exterior surfaces to char.

In contrast to the E wall, the SW corner exhibited a very different pattern of magnetic susceptibility. The ground surface outside the building here demonstrated very little elevation in magnetic susceptibility, suggesting that relatively scant thermal energy was transmitted from the collapsed wall timbers to the ground surface. Assuming similar levels of background magnetic susceptibility across the site, the evidence suggests that the wall planks in the SW corner of the building fell while relatively cool at their base and hotter towards their tops, where they continued to burn following collapse. The limited combustion suggests that collapse was highly unlikely during the peak of the fire; rather, an early partial collapse before complete development is a more likely model. The photographs taken during the fire also show there was already an advanced state of collapse before the peak of combustion. The collapse of the timbers in the SW corner at a relatively early period within the fire's duration also increases the likelihood that the point of origin was located in this area.

The survey demonstrates that magnetic techniques can usefully assist in detailing patterns of burning and collapse, and this can directly inform the processes of archaeological fire investigation, for both SFBs and especially ground-level buildings where there might otherwise be little surviving evidence (see above). In addition to intensities of areas of burning, the effects of combustion have been shown to assist with revealing elements of structural detail, such as the position of uprights burnt *in situ* and the orientation of openings revealed through preserved indicators of radiated heat. Moreover, the use of intensive magnetic susceptibility sampling even on the stripped subsurface, on a closely-spaced grid, might help to identify the remains of burnt buildings, which are otherwise not apparent.

VI. Conclusions

Can a point of origin for the fire be suggested?
A range of investigative techniques have been employed on the remains of the Farmer's House. These techniques utilised both damage-intensity related and directional indicators to try to build up a complete picture of the nature of the fire and the subsequent collapse of the building. In consideration of the pattern preserved in the levels of timber charring, the massed concentrations of timber used in the construction of the building might, on first observation, appear to offer a wealth of potential measurements for the depth of char throughout the structure.

In reality, the nature of the Farmer's House, as an almost entirely combustible structure, has made the task of suggesting a seat of fire and subsequent sequence of development of the blaze far harder than in modern structures. Contemporary compartments that are generally the subject of forensic examination tend to feature a broad range of materials, but the structure of the compartment itself is generally non-combustible, leaving a static shell on which traces of the direction and development of the burning might be preserved. By contrast, a timber structure subject to extensive fire damage and subsequent collapse can present a swathe of charred material which, if subject to extensive fragmentation following deposition, can be extremely difficult to reconstruct in terms of the original building.

By restricting the application of investigative techniques to those timber elements of the Farmer's House that offer relatively uniform dimensions and were situated throughout the structure, and that remained relatively static throughout the fire, it is possible to get a reasonable plan of the relative intensity of damage across the entire structure.

By utilising the outer floor joists at ground level in this way, it has been possible to draw attention towards those

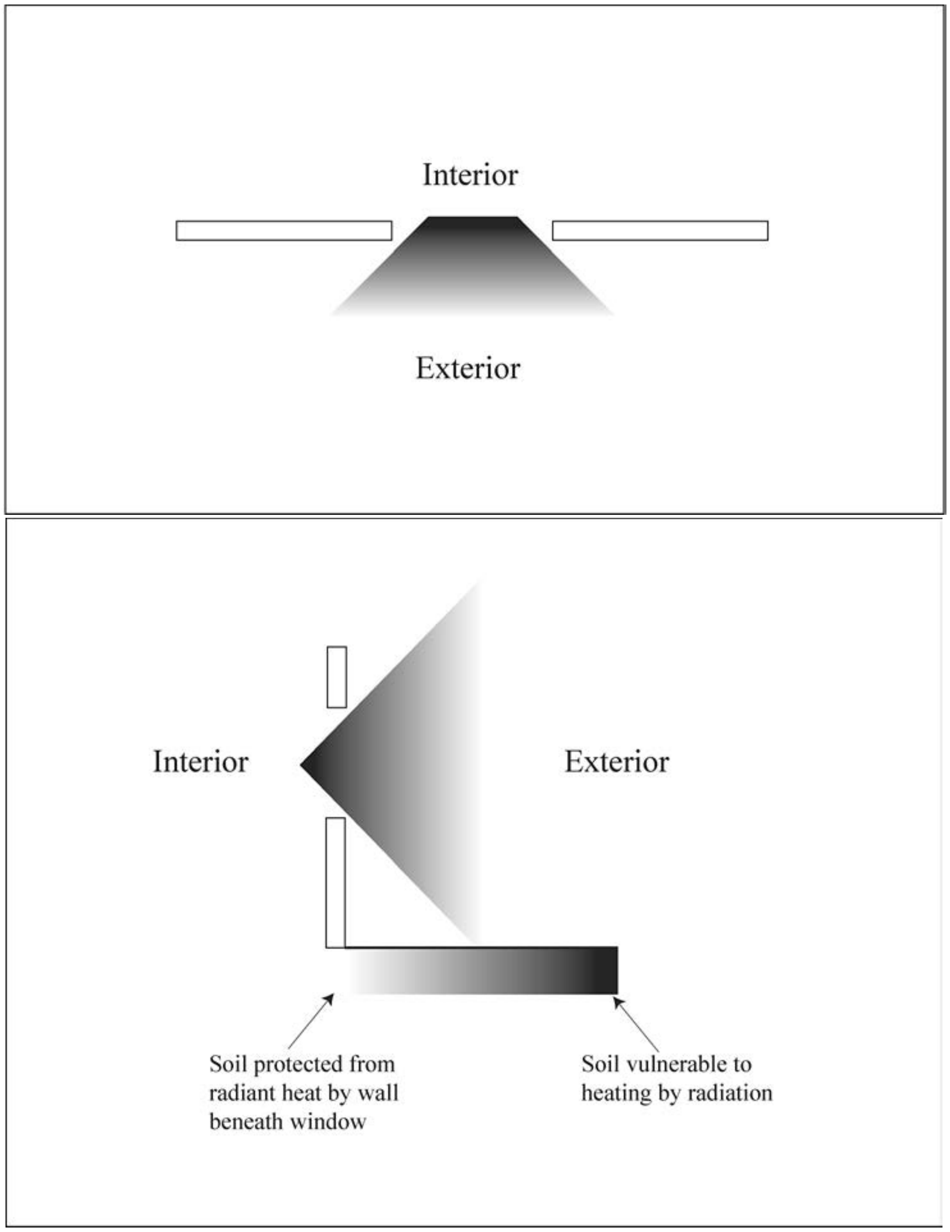


Figure 6.5 Schematic illustration to show the spread of radiated heat through doorway (top, in plan) and window (above, in section)

areas where the joist had been subjected to complete combustion. In certain circumstances, there appeared to be a clear reason why such a massive timber might suffer such intense damage, whether it be due to the concentration of fuel mass in relation to a greater fuel surface area, as at the corner lap joints, or a localised increase in the rate of ventilation, as with the apparent animal burrow along the N side of the building. Where no such circumstances were immediately apparent, the area in question might prove suitable for consideration as a potential seat of fire and site of its growth during the development phase of the blaze.

Two further areas of total combustion are somewhat harder to explain, and more likely to relate to damage received during the early development phase of the fire. One of these is located at the SW corner. It has been suggested that this is unlikely to relate to any specific effect of the window, because of the relatively early collapse of the window frame during the fire (demonstrated by the relative lack of damage to the shutter slats), but rather has been brought about by continuing smoulder damage following the main fire. The final area, at the S end of the E (N–S) floor joist is hard to explain with reference to the physical constraints of fire, fuel and ventilation, although it might have been related to a vented area beneath the joist that is apparent on the construction photographs (Plate 6.3).

This pattern of damage highlights the S side of the building, and in particular the SW corner, as being that most likely to feature damage relating to the initial phases of fire development. It is also corroborated to some extent by the observation of the linear patterns of destruction on the ground to the E and W of the building (Plate 6.4). It has been suggested that these parallel lines of damage in the form of fragmentary char relate to a shearing of the upper section of the frame. Given the relatively good levels of

Reasons for suspecting arson from general circumstances	
Consideration	*Observation regarding the Farmer's House*
Evidence of forced entry	It has been shown that it is unlikely that the window slats were blown out by the action of fire, or by explosive decompression of the extinguisher. The slats are scorched, however, indicating that they were present at least at the start of the fire and suggesting they were forced out by mechanical action, rather than in the act of breaking in
Repeated or numerous fires	Earlier fires at West Stow have been traced back to accidental causes related to the design of the fire-boxes, which have since been rectified. Previous trespass on the site has been noted, however
The same person present at different fires	N/A
Fire-fighting difficulties	Difficulties of access and availability of water experienced by Suffolk Fire Service were due to the nature of the site, rather than action taken by an arsonist
Interference with the fire prevention/protection measures	
a) Fire resistant doors	N/A
b) Fire extinguishers	The fire extinguisher was clearly disturbed, as the body of the cylinder was found to be lying across the W (N–S) outer floor joist. This can only have occurred following the collapse of the upstanding wall at the peak of the first fire. No disturbance can therefore be related to interference by arsonists
c) Sprinklers	N/A
d) Fire detectors	N/A
Persons wrongly dressed or prepared	N/A
The fire appears to be specifically targeted	The Farmer's House was one of the largest structures on the site, and was centrally located within the Village; this may suggest some degree of targeting, but is not conclusive
The fire would be financially advantageous	N/A

Reasons for suspecting arson at or after the scene investigation	
Consideration	*Observation regarding the Farmer's House*
Multiple seats of fire	Investigation has suggested two areas to the E and W of the S wall that might potentially represent two separate seats of fire
Unusual or unnatural disposition of contents	Requires better knowledge of pre-fire layout of the Farmer's House
Extraneous materials at seat of fire	None apparent
Unusually severe fire for the known characteristics	Fire far more severe than would be expected for 'standard' traditional timber-framed structure, but this has been explained with reference to the nature of the Farmer's House
Unusually rapid fire development	Rate of development consistent with other timber-framed thatched structures
Atypical fire spread patterns	A typical nature of fire development appears to relate to the design of Farmer's House, predominantly presence of lined cellar
Evidence of articles missing from building	No
Value of stock mismatched with claims	N/A
Evidence of a further crime	None apparent
No recognisable accidental cause	Elimination of involvement of fire-box would suggest lack of obvious accidental cause
Technical conclusions failing to match witness statements	The conclusions of both the fire engineering and investigative elements of the examination have been found to match closely with observations made by witnesses at the scene
Obstructive behaviour by occupier	N/A

Table 6.4 Indications characteristic of deliberate ignition (after Cooke and Ide 1985)

preservation of the upper portions of the boards forming the E and W walls, this would suggest that the fire affected one or both of the S corners of the building at an early stage in the development of the fire.

The parallel lines appearing to pivot from the SE and NW corners of the building, along with the patterns of charring along the outer joist, suggest a point of origin towards the front (S) face of the building rather than the N. The stratigraphy of collapse favours a point for the fire's initial development towards the SW corner.

The SW corner of the interior of the Farmer's House, in which the fire extinguisher was located, was relatively clear of obstructing fixtures and furnishings. Under the Fire Precautions (Application for Certificate) Regulations 1989, the number and location of fire extinguishers and other precautionary devices would have to be recorded and passed by the relevant fire authority. Despite an apparent lack of significant concentrations of fuel in this corner of the building, the damage noted on the extinguisher indicates that this area had reached

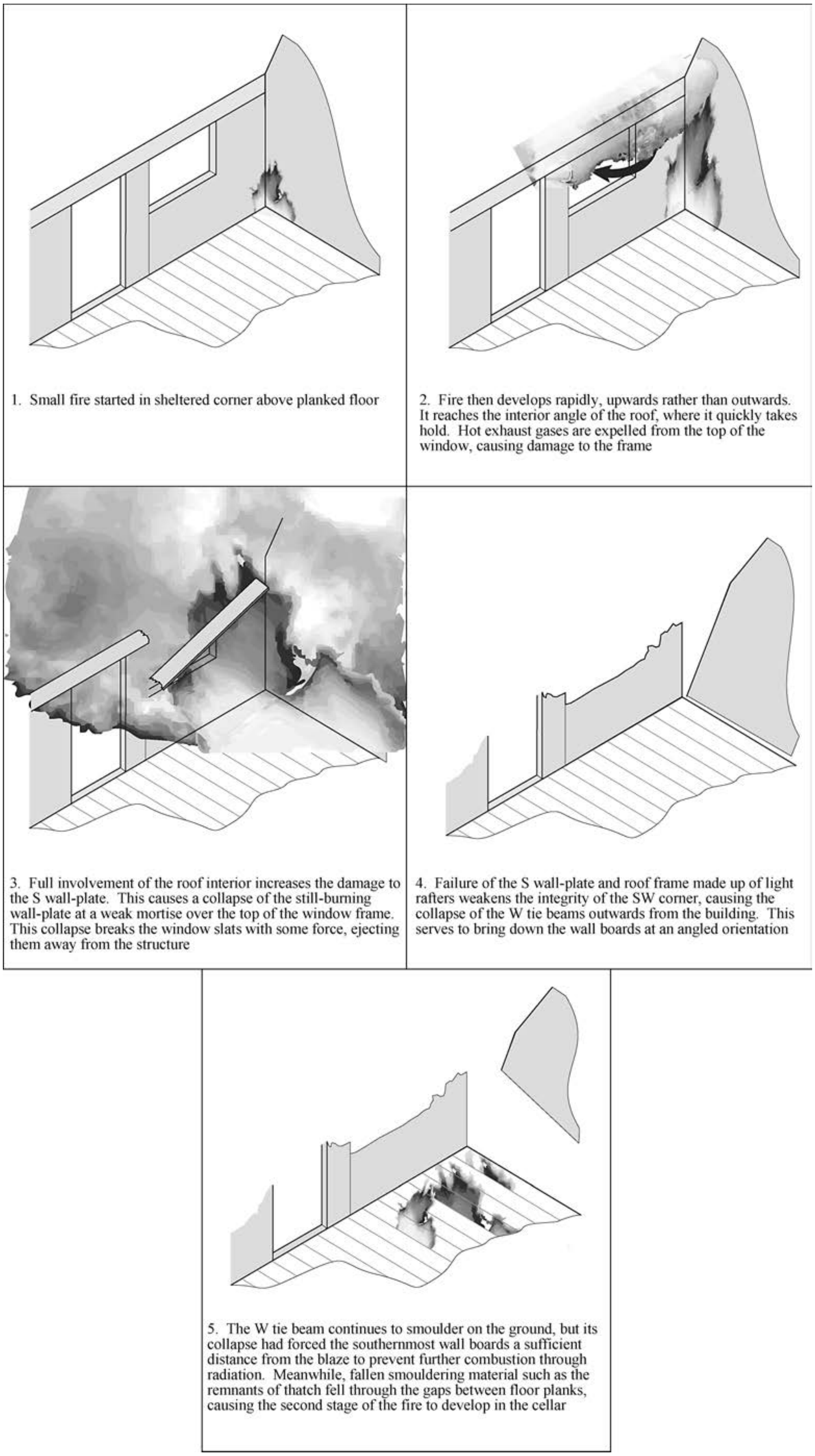


Figure 6.6 Schematic illustrations of the building to show the projected development of the fire from its initial seat in the Farmer's House

temperatures between 900–1200º Celsius, comparable with modern compartment fires.

A potential seat of fire in the SW corner, and within the interior, of the Farmer's House supports a hypothesis of deliberate ignition. As an area of relatively low fuel concentration, items would have had to be introduced in order to feed a small fire through its initial development phase. In addition, the fragmentation of pottery in this area, from the raised platform above the tie beam, and its position in the stratigraphy of debris suggests that it fell at a relatively early stage in the fire. Furthermore, this area of the building is some distance from the fire-box, which represents the sole potential accidental agent of the fire. One other possibility to be considered would be the development of a slow-burning smouldering fire at or around the fire-box that succeeded in penetrating the surrounding floorboards. This could have introduced material into the cellar which then brought about a fire within the cellar. The pattern of collapse would seem to mitigate against this, however, as the evidence suggests rapid development of the initial fire and very little thermal damage in parts. Development of the fire in a corner of the building would also explain the rapid involvement of roof material, given that the growing flames would very quickly come into contact with the lowest point of the eaves.

Can a manner of development be suggested?

The initial attempt to provide a theoretical model for the development of fire, relying on principles of fire engineering, concluded that a complex and unusual pattern of two-phase burning was the most likely course of growth and resolution for a compartment fire. Additionally, observations made of the traces of damage within the building suggested an initial seat of fire in the SW corner of the building. It remains to be seen whether the manner of ignition and development can be advanced that might unite these observations into a coherent narrative of the sequence of destruction. In terms of a how the fire started, Cooke and Ide (1985) put forward a list of considerations that might point a fire investigator towards a verdict of deliberate ignition. Whilst these are designed to be of use in a forensic context, a number of them prove informative with regard to the Farmer's House, and more generally when considering structural fires in the archaeological record (Table 6.4).

Although a significant number of the conclusions recorded in Table 6.4 are not applicable to the fire at the Farmer's House, several stand out as being particularly suggestive of a deliberate ignition. A range of observations related to damage intensity, the stratigraphy of structural collapse and the photographic evidence of the progress of the fire itself imply that the SW corner is a likely potential seat of the original fire. This area was relatively clear of potential fuel concentrations and lacked any obvious means by which a fire might start accidentally.

Whilst the extent of the destruction precludes any definitive conclusions regarding the development phase of the fire, the sequence suggested in Fig. 6.6 refines the modelled development suggested in Fig. 6.3, and would seem to reflect and make reference to the observations that have been made.

This proposed sequence of development brings together observations from the original material with the theoretical models developed in the first section of the chapter, based on estimates of the level of available fuel and ventilation. Both of these different sets of information tend to complement rather than contradict each other.

7. Discussion

I. Introduction

A summary of the findings is presented in this chapter, and some of the wider implications for interpreting and understanding archaeological remains of burnt SFBs are discussed. Following a discussion of the causes of building fires, the evidence from previous investigations of burnt SFBs in Anglo-Saxon England is summarised. This is followed by a summary of some examples of late Saxon and early medieval cellared buildings, also destroyed by fire, that have been investigated in Ipswich, which possess structural similarities to the Farmer's House reconstruction at West Stow. The difficulties in identifying burnt ground level buildings from the often fragmentary surviving archaeological evidence is also discussed, both during this and other periods. The evidence from the Farmer's House is compared with the few burnt SFBs that have been investigated, in particular SFBs 3 and 15 from West Stow, and a number of observations are made about the original interpretation.

II. The causes of building fires

There are two possible causes for the destruction of a building by fire. The first is accidental, and there are a number of references to unintentional fires in the documentary sources for the Anglo-Saxon period. In Book III (Chapter X) of his *Historia Ecclesiastica*, completed in AD 731, Bede recounts a miracle of how a Briton took a bag of soil from the ground on which Oswald, king of Northumbria, had died in battle. He entered a house in the evening and sat down to feast with the villagers around the great fire in the midst of the dwelling. 'It happened that sparks flew up to the roof which was made of wattles and thatched with hay, so that it suddenly burst into flames' (Colgrave and Mynors 1969, 245). According to Bede's account, the whole house burned down except for the post on which the bag of soil had been hung. While there is a need to be wary of the reliability of the miracle itself, the passage tells us how easily a building of this period could be destroyed by fire.

It is not difficult to understand how a dry timber building with a thatched roof might be destroyed by fire, given the large quantities of combustible material involved in the fabric of these structures. In the accidental fire within the Farmer's House, six months before it was destroyed, it took three fire extinguishers to put out the small fire that occurred below the fire-box (Chapter 3). The fire that destroyed an experimental reconstruction of an Anglo-Saxon Hall at Bishops Wood Centre, Worcestershire, in November 2008 was an unfortunate accident[i]. In that case, the Fire Service identified the seat of the fire below the raised floor on joists above the ground surface. The lining of the central fire-box burned through and a smouldering fire spread along one of the floor joists, and subsequently spread to the rest of the building. The Fire Service was unable to prevent the complete destruction of the building (J. Rhymer pers. comm.)[ii].

During the Roman period, a number of buildings have been excavated with evidence to suggest they had been destroyed accidentally by fire. At Beck Row, Mildenhall, Suffolk, for example, two large aisled buildings, both interpreted as barns used for grain processing and dating between the mid 2nd and mid 3rd centuries AD, had been destroyed by fire. This was indicated, in particular, by the presence of charcoal within the post-pipe fills of the structural post-holes; in both cases the surface deposits had been largely destroyed (Bales 2004, 11–19). There would have been a fire hazard associated with the drying and milling of grain and, therefore, it was suggested that both buildings had been destroyed accidentally (Bales 2004, 62–3). At Great Holts Farm, Boreham, Essex, a probable aisled building (294), also interpreted as a granary and with a raised wooden floor, was destroyed by fire during the late 4th century (Germany 2003, 49–50, 222). Again, preservation was generally poor and the fire was indicated by the presence of large amounts of charcoal, and carbonised macrofossils, in the post-extraction cuts that had been backfilled with tile and other debris. In addition, a large amount of carbonised macrofossils — the remains of the grain stored in the building — was situated in a tile spread, *c*.0.20m thick, preserved on the subsoil in a central hollow; the actual tiles, presumably from the roof of this building, were unscorched.

If one building caught alight it is also easy to appreciate how a fire might spread to other nearby buildings. In the account of another miracle, Bede (Book I, Chapter XIX) tells how, because of an accident, a cottage caught fire next to where Germanus lay sick after his visit to the tomb of St Alban. He states, 'the other dwellings which were thatched with reeds were destroyed and the fire, fanned by the wind, approached the house where he lay'. Germanus' building was protected from the flames by 'the power of God' (Colgrave and Mynors 1969, 61). In Book II (Chapter VII), he also records how Canterbury 'had been carelessly set on fire and was rapidly being consumed by fire' (Colgrave and Mynors 1969, 157).

Thatched roofs were a particular danger because flames could spread quickly from roof to roof. Consequently, fires were frequent in medieval towns, where the technology of fire-fighting was also weak. The only effective fire-fighting practice was to create fire breaks by pulling down buildings, with the use of fire hooks to pull off the burning thatch, leather buckets and ladders. There were two major fires in Norwich in 1507, for example, which destroyed a reported 718 houses (Porter 1986, 310). As a result, Council at Norwich prohibited the use of thatch on all new buildings in 1509, although this proved difficult to enforce. Other towns introduced similar measures in the 15th century. Medieval and later corporations also tried to banish occupations that used open fires. However, it was not until the later 17th century that brick and tile were adopted on a large scale in provincial towns and, as an immediate consequence of the use of these nonflammable materials, there was a reduction in the high incidence of fire (Jones and Falkus 1990, 121). In 1077, 'London was burnt 'so terribly as it never was before since it was built'' (Salzman 1992, 223). Ten years later there was another major fire that destroyed a large part of the City, including St Paul's Cathedral. The Great Fire of 1666 is graphically recorded by contemporary accounts, including Samuel Pepys and Thomas Vincent, which destroyed over 13,000 houses, 87 parish churches and St Paul's Cathedral. The fire started in late summer in the waterfront area, where large quantities of combustible material were stored. It spread rapidly, between dry and old timber buildings, and along narrow streets, fanned by a strong E wind (Milne 1986, 21–2). The Great Fire, however, 'has obscured the frequency and seriousness of urban fire damage that in reality lasted until the eighteenth century' (Jones and Falkus 1990, 121). Although smaller in scale, one in 1748 destroyed 118 houses and another in 1794 destroyed over 600 (Jones and Falkus 1990, 122).

The cause of the fires that resulted in the destruction of SFBs 3 and 15, with their contents, at West Stow is not explicitly discussed by West (1985). West does suggest that the destruction of two buildings, within the same part of the site *c*.20.00m apart and dating to the same phase of occupation, is probably not coincidental. He suggests it is likely they were destroyed in the same conflagration (West 2001, 17). It is assumed that the excavator considered the cause of these fires to be accidental and this is supported by the review of the evidence (see below), which suggests they were destroyed as a result of material smouldering below their suspended floors. It is not hard to imagine how a fire could have passed from one building to the other. It is also possible, however, that they were deliberately destroyed at the end of the settlement, as they were in the latest phase of occupation, although this does not adequately explain why both the sunken features were deliberately filled in and the burnt remains covered over if the fires were an act of site abandonment. Either way, there was no apparent evidence to suggest the remains had been scavenged, to recover re-usable and valuable items (which has sometimes been taken to indicate deliberate and ritual destruction; see below), although it is debatable whether or not any evidence for this would be discernible in the archaeological record. Moreover, loomweights were simply utilitarian and low value objects that could be easily replaced (Tipper 2004, 169) and there were otherwise few artefacts within these sunken features.

The second way a fire might start is through a deliberate and intentional act. This might be during a period of hostility and disturbance. In the 1st century AD, for example, the destruction of Camoludunum by fire during the Boudiccan revolt is recorded by Tacitus in *The Annals* (Book XIV.32; Jackson 1969, 161) and there is now considerable archaeological evidence for this event from a number of major excavations in Colchester (Crummy 1997, 79–84). In the Anglo-Saxon period, in Book II (Chapter XIV) of the *Historia Ecclesiastica*, Bede records how a church and all the buildings (including a royal dwelling) were destroyed by fire 'by the heathen men who slew King Edwin' (Cædwalla supported by Penda) at Campodunum in Deira (Colgrave and Mynors 1969, 189). In Book III (Chapter XVII), he records how during the mid 7th century Penda 'came with a hostile army to these parts destroying everything he could with fire and sword; and the village in which the bishop had died [Bishop Aidan, who died on a royal estate near Bamburgh] together with the church just mentioned, was burnt down' (Colgrave and Mynors 1969, 265). The wooden buttress of the church upon which the bishop was leaning when he died 'could not be devoured by the flames though they destroyed everything around it'. He continues, 'shortly afterwards it happened that the same village and church were again burned down, this time through culpable carelessness. But on this occasion too the flames could not touch the buttress' (Colgrave and Mynors 1969, 265). At Yeavering, Hope-Taylor linked the destruction of buildings in Phase IIIc and Phase IV to the acts of hostility recorded by Bede (1977, 163; see below).

The punishments for arson are specified in a number of the earliest Germanic law codes (although there are none in the earliest English lawcodes), suggesting that buildings were sometimes deliberately set on fire in the early medieval period, presumably during disputes or feuds. The law code of the Salian Franks, the *Lex Salica*, compiled under Clovis and dating to the early 6th century (although the earliest manuscript of it extant is dated to *c*.AD 770), specifies the punishment for setting fire to another's house, with and without people inside (Fischer Drew 1991, 81; McKitterick 1989, 40–60). There are also fines in the *Lex Salica* for setting fire to a person's barn, granary, pig sty, stable, hedge or fence. There are similar laws relating to arson in the Alamannic Laws and in the Bavarian Laws (Rivers 1977, 94–5 & 146–7).

There is a further possibility relating to intentional destruction that has been discussed in studies of prehistoric Europe, referred to as 'structured or 'ritualised' house abandonment behaviour' (after Webley 2007; LaMotta and Schiffer 1999, 139). This has rarely been considered during the Anglo-Saxon or later periods. LaMotta and Schiffer (1999, 23) defined 'ritual formation processes' as 'deposition that departs markedly from least-effort expectations'. They referred to the US Southwest where the indigenous peoples reportedly burned their houses on abandonment, 'usually as a result of the death of one or more of the occupants' (1999, 23). Brück (1999, 153) has also referred to SE Asian societies in which the house is considered to be an animate object with its own vital force. In these societies, houses are symbolically linked to, and a metaphorical representation of, the lifecycle of households. The well-being of both is intimately connected and rites analogous to those enacted upon the death of a person were carried out when a village was partly destroyed by fire (Brück 1999, 153).

Although ethnographic examples are culturally specific, both in time and space, they do offer possibilities for the archaeological record. From a 21st century perspective, the ritual destruction of a building may seem extremely wasteful; many timbers would probably be reusable. However, the ethnographic examples indicate that the evidence should not be perceived in modern functional terms (Brück 1999, 153; Chapman 1999). It is, therefore, possible that a building might be intentionally set alight as a 'structured' act in which a building was 'sacrificed' through burning, and this should also be considered as a possibility during the Anglo-Saxon period.

The ritual destruction of buildings by fire has been suggested in a number of cases within prehistory, drawing on the possibilities suggested by ethnographic evidence.

At Longbridge Deverill, Wiltshire, a series of at least three great Iron Age roundhouses destroyed by fire was investigated between 1956–60 (Chadwick Hawkes 1994). It was suggested that their destruction may have been a funeral rite, 'which involved the deliberate burning of a dead man's house with its contents' (Chadwick Hawkes 1994, 68). Similarly, Brück (1999, 154) has suggested that the destruction of a Middle Bronze Age building at Mile Oak, East Sussex, might have been a 'deliberate act to end the life of the building'. Brück (2006) suggested that the deliberate burning and breaking was an essential role linked to the renewal of life in Middle and Late Bronze Age Britain. Brück (1999, 155) also suggested that the deliberate act of destruction might relate to a 'bad death' among the occupants.

In the Neolithic and copper age of central and eastern Europe, the destruction of wattle and daub houses or groups of houses was a frequent event, especially on tell sites, to judge from the number of burnt buildings that have been discovered and that are widespread both in time and place (Chapman 1999). A variety of reasons have been put forward to explain this. Stevanović and Tringham see house burning as a ritual performance marking the end of a house in social memory and coinciding with the death of a significant person (Tringham 2005, 105; Stevanović 2002). Chapman suggested that deliberate destruction was intended to complete the life-cycle of the house (Chapman 1999, 117–120). He explained the practice in terms of social reproduction, 'exchange between the living and the ancestors, in which the living destroy their material culture in return for good ancestral relations' (Chapman 1999, 120). However, such deliberate house burning was probably rare in the lifetime of most individuals, and probably related to the death of a significant leader within the whole community (Chapman 1999, 122). Moreover, the movement of burnt material (specifically daub) from burnt houses to other contexts, it has been suggested, 'provides a way of presencing the ancestors, a power resource upon which future households can draw for an expression of their continuity with the past' (Chapman 1999, 123).

During the early medieval period in Scandinavia, it has also been suggested that some houses were deliberately burnt. Thäte (2007, 188) cites references in the Icelandic Sagas that indicate high status people were sometimes burnt in their houses. Similar to the ethnographic examples from SE Asia (Brück 1999, 153), there is evidence from Scandinavia to suggest that sometimes a house 'died' when an individual died (Thäte 2007, 188). Thäte put forward a number of explanations for the deliberate burning of houses during the Viking period, some of which were later re-used for burial – possibly on the death of an important individual, or on the extinction of a family lineage, or possibly when buildings were abandoned without return (see also Bradley 2005, 79). However, the explanation normally favoured by Norwegian archaeologists for the destruction of buildings by fire, Thäte suggested, is that of war and hostility (2007, 188).

It should be emphasised that these examples are limited in time and location. They are used here merely as possibilities to show that there might be rituals of varying kinds associated with house abandonment and, that we should at least allow the possibility that there may have been similar activities during the early Anglo-Saxon period. Unusual, special or placed deposits have been identified in early Anglo-Saxon England and these might also mark the construction or abandonment of buildings (Hamerow 2006). In Bronze Age Britain, for example, the ritual destruction of buildings by fire and deliberate deposition of broken objects has been seen as part of the same set of ideas or ritual practices linked to transformation and regeneration (Brück 2006). Therefore, we should at least acknowledge the possibility that buildings might have been deliberately destroyed. Certainly, the importance of fire to religious belief during the early Anglo-Saxon period in the east of England is demonstrated by the use of cremation as a burial rite, with the collection, display and destruction by fire of substantial quantities of resources.

The ritualised destruction and closure of a late Anglo-Saxon cellared structure from Bishopstone, East Sussex, reconstructed as an elaborate towered structure, has been recently proposed (Thomas 2008). The excavator suggested 'a stratigraphically definitive case of closure marked by the burning, deliberate dismantlement and backfilling' (Thomas 2008, 387). A hoard of ironwork buried in one of the corner post-holes of the cellar was interpreted as closing deposit, placed after the structure had been destroyed but before the cellar was infilled (Thomas 2008, 382).

The only evidence, however, to suggest the Bishopstone structure had been destroyed by fire was a thin spread of oak charcoal across the base of the cellar, although the charcoal contained a large number of iron objects dominated by structural fittings (Thomas 2008, 347). There was no evidence for scorching to either the base or sides of the pit which, it was suggested, had been lined with post-and planks or wickerwork (Thomas 2008, 351), and the possibility that the burning occurred *in situ* was ruled out. This evidence stands in contrast to the Farmer's House, which had a complex two-stage compartment fire, with a rapid and low-intensity flaming combustion of the above-ground structure followed by a more intense and comprehensive cellar fire (Chapter 5). Based on comparison with the experimental reconstruction at West Stow, it seems unlikely that the Bishopstone structure was actually destroyed by fire, as the superstructure would almost certainly have collapsed down into the cellar and resulted in a similar, comprehensive fire. Instead, it seems more likely that the material on the base of the cellar has been collected from elsewhere, perhaps from the remains of another structure that was destroyed by fire given the structural fittings within the deposit. Moreover, it is just possible that the hoard of iron objects represents a foundation deposit placed around the post, which has subsequently slumped down as the post has decayed *in situ*. The position of the post is marked by a sub-square void and the post would have been placed against the corner of the pit (Thomas 2008, illus. 10–11).

III. The evidence of burnt SFBs in Anglo-Saxon England

There are now a large number of SFBs that have been excavated in this country (Tipper 2004). The majority, however, have produced little evidence to contribute significantly to the debate on the structural reconstruction of this type of building, mainly because there is little of the

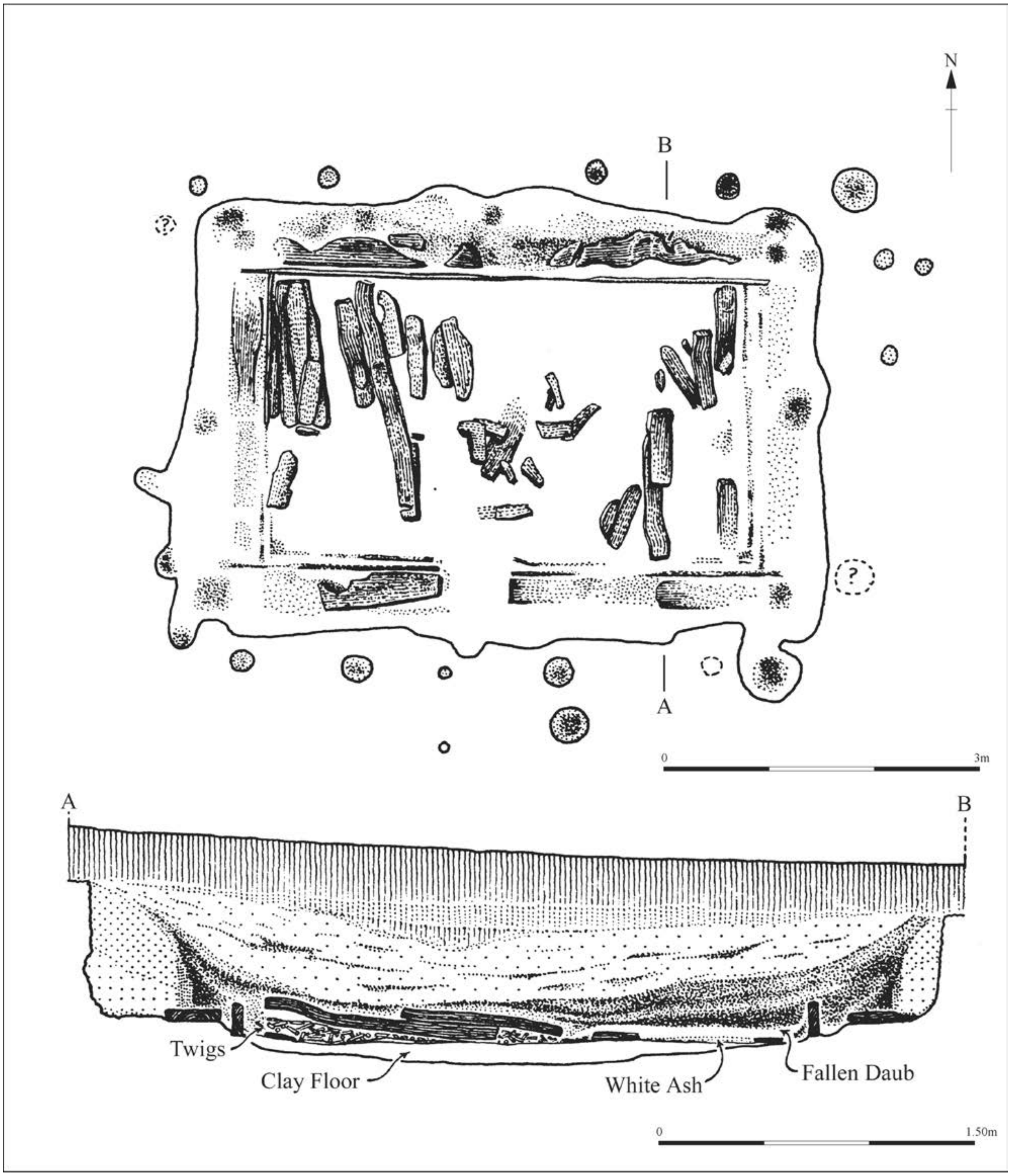


Figure 7.1 Plan and section of Building C1 destroyed by fire at Yeavering, Northumberland. Source: Hope-Taylor 1977, fig. 37. *Crown Copyright as licensed to English Heritage*

superstructure surviving. Occasionally, soil stains indicate the position of posts and planks but more often than not there is little structural evidence, which is why there has been so much discussion about the structural form of SFBs (Chapter 1).

No waterlogged examples of early Anglo-Saxon SFBs have been discovered and they were not generally constructed in low-lying areas prone to flooding. At least, none have been yet discovered and the pattern of settlements during the early Anglo-Saxon period seems to be relatively clear, generally situated on light soils and, in particular, on terraces within river valleys (e.g. Hamerow 1992). Therefore, it seems unlikely (although not impossible) that many waterlogged SFBs will be discovered in the future. An exception, dating to the Middle Saxon period, is from Whitehall (Building U2), Middlesex, excavated in 1961–3 (Green with Cowie 2008, 92–3 and fig. 96). A SFB, 7.80m x 6.60m in area x 0.70m deep, interpreted as a sunken-floored building (although there was no evidence of an occupation deposit on the base), possessed well-preserved wooden remains within the sunken area. There were the remains of substantial sillbeams, 0.30m wide, at the base of the sides and oak planks, 0.15–0.23m wide x 25mm thick, lying both ways across the feature, which were interpreted as wall planks, and also poles 75mm in diameter. The sunken area was 'deliberately filled with vegetation, possibly bracken or reeds, which eventually formed a peaty loam' (Green with Cowie 2008, 93). It seems possible that this material represents the remains of roofing material that collapsed into the base of the sunken feature.

In the late 10th century, sunken-featured structures have been preserved by waterlogging in Anglo-Scandinavian levels at 16–22 Coppergate, York (Hall 1994). This has preserved an exceptional level of evidence about the form and construction of the basements or cellars, as well as about timber building techniques and woodland management (Allen and Spriggs 2002).

There is a small group of SFBs investigated in this country, however, that were destroyed by fire, with charred structural remains preserved in the base of their sunken feature. These provide an extra level of information and contribute significantly to the debate about the structural form of this building type. However, their interpretation is often challenging because of the fragmentary nature of the charred remains. Two of the most informative examples are both from West Stow (SFBs 3 and 15; Chapter 1). These form the basis for the detailed comparison with the evidence from the Farmer's House.

Direct comparison between the evidence from the Farmer's House and SFBs 3 and 15 is, however, problematical. In particular, the depth of the sunken features from both SFBs 3 and 15 was less than half the depth of the cellar from the Farmer's House; the estimated depth from the original ground surface was 0.61m for SFB 3 and 0.69m for SFB 15. This compares to a depth of 1.40m within the Farmer's House. The depth of the Farmer's House cellar served to limit ventilation in the later stages of the fire, which exacerbated its destructive capability far beyond the initial estimates of the attending fire crews (Chapter 6). Moreover, the Farmer's House had a substantial, timber-lined cellar. In comparison, SFB 15 did not appear to have any lining around the sunken feature. SFB 3 had 'a most unusual arrangement of secondary post-holes irregularly spaced around the perimeter of the pit' (West 1985, 16; Fig. 1.6). Both SFBs 3 and 15 had two structural post-holes, indicating two ridge-posts, compared to the six within the Farmer's House.

These differences are likely to have had a considerably different effect on the nature of a fire within these buildings, whether or not they had similar superstructures. The massive concentrations of fuel in the Farmer's House, in the form of six substantial posts and the great quantity of timber fixed into the cellar lining, served to fuel the fire far longer than would a less engineered structure (Chapter 6). The Farmer's House also had a large window next to the door and this opening will have served to increase the level of available ventilation. Although there is only a small amount of evidence from this period, and it is all late, it seems that Anglo-Saxon buildings had small, triangular peep-hole windows (e.g. Goodburn 1994, 51 and fig. 6; Malcolm *et al*. 2003, 156).

The structural differences mean that the buildings would have behaved in markedly different ways during a fire. Nevertheless, the evidence from the Farmer's House does provide valuable comparative evidence for these (and other) SFBs because, as discussed in Chapter 1, both SFBs 3 and 15 appeared to possess suspended planked floors, vertical planked walls and thatched roofs, which formed the basis for the experimental reconstructions at West Stow (West 1985 and 2001).

In addition to the two from West Stow, a burnt SFB was excavated at the royal palace or *villa regia* at Yeavering, Northumberland, between 1953 and 62 (Hope-Taylor 1977; see below). The Farmer's House is more similar in terms of size and depth of the pit to the SFB (Building C1) destroyed by fire at Yeavering (Hope-Taylor 1977, 88–91 and fig. 37; Fig. 7.1). The sunken feature associated with Building C1 had evidence of lining around its sides, and the lowest planking survived *in situ*, as 'a series of [horizontal] planks set on edge, like skirting boards' (Hope-Taylor 1977, 90). While the structural details are different, the remains of the plank lining is remarkably similar to the remains of the lowest *in situ* lining within the cellar pit of the Farmer's House. Moreover, the lined area (*c*.4.50 x 2.75m) was considerably smaller than the overall area of the pit cut (*c*.5.90 x 4.25m) and it was also apparently constructed as a free-standing box[iii]. However, Hope-Taylor interpreted the evidence as the remains of a sunken-floored building with vertical wall planks, set within the base of the pit, and with a roof at ground level, with rafters set directly into the ground. The sunken feature was *c*.0.65m deep (*c*.1.00m deep from the modern ground surface), of which the lowest 0.10m comprised a clay floor surface.

Like the evidence in both SFBs 3 and 15 at West Stow, there were a large number of charred planks aligned N–S across the base of Building C1 in a reasonably orderly and neat arrangement. Three of the planks were *c*.1.35m long; the longest, described as a probable rafter, measured *c*.2.30m. Again, like the evidence at West Stow, in places a number of the planks were overlapping and lying on top of each other. Instead of collapsed floor boards, however, Hope-Taylor interpreted these as the remains of the 'fallen timbers of its north wall' that were originally located between the *in situ* skirting boards (Hope-Taylor 1977, 90). He suggested that a layer of crushed clay and twigs directly below, and on the base of the pit, was the remains of an internal screen or facing of wattle and daub. The widely spaced post-holes, *c*.2.10m apart, located on the surface, beyond the edge of the pit and *c*.0.90m from the position of the lined pit, were thought to hold the lower ends of the rafters. Alternatively, it seems possible that the charred planks were the remains of a suspended floor above a lined cellar, which collapsed down onto the base of the pit.

Hope-Taylor put forward a sequence of development for the fire based on the physical remains of the building, combined with the evidence from a number of others that suggested a similar sequence, and also he suggested based on experimental modelling and modern fire investigation (Hope-Taylor 1977, 44–5, 90). He suggested that the NE corner of the building caught fire first because the deposit of white ash across the base, containing 'twigs and pieces of straw or reeds' that he interpreted as the remains of roof-thatch, was thickest in this corner (Hope-Taylor 1977, 88). Subsequently, the upper rafters gave way followed by the N wall, which fell inwards. The wall boards burned uniformly below the remains of the roof, which acted as a 'smother kiln' and preserved the boards as charcoal.

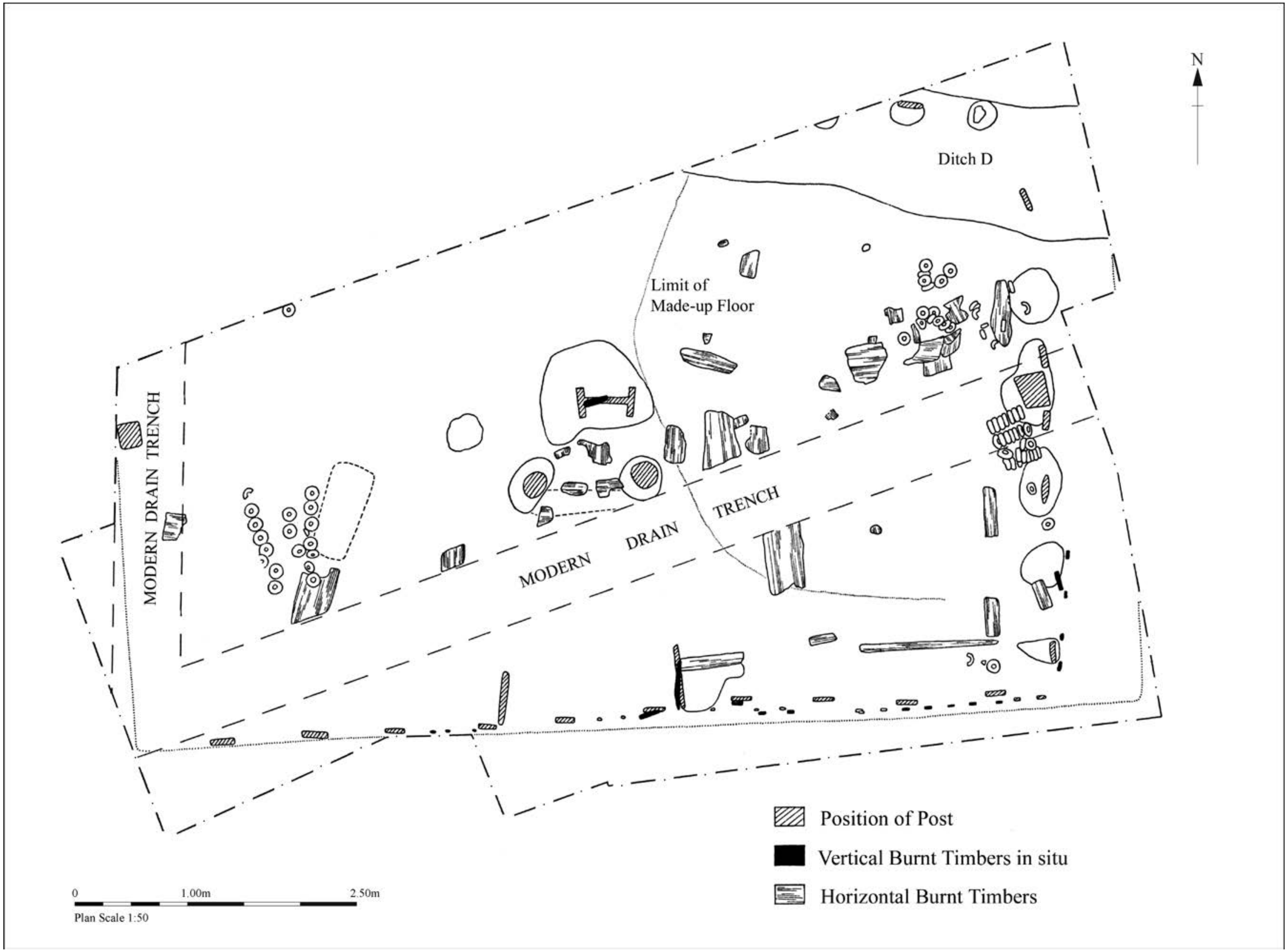


Figure 7.2 Plan of a large Anglo-Saxon sunken-floored building destroyed by fire at Upton, Northants. Reproduced by kind permission of the Society of Antiquaries of London from *Antiquaries Journal* 49, Jackson *et al*. 1969, fig. 4, *Copyright reserved*

Plate 7.1 The large sunken-floored building destroyed by fire at Old Swindon (viewed from E). The row of loomweights on the base and against the (S) W side of sunken feature are mainly unburnt. The burnt remains seem to be concentrated to the N of these and in a NW–SE zone across the base of the building. Scale at 0.50m intervals. *Courtesy of Bernard Phillips and Roy Canham*

The partial remains of a large sunken-floored building, *c*.9.10 x 5.50m in area x *c*.0.60m deep, was investigated under rescue conditions at Upton, Northants, in 1965 (Jackson *et al*. 1969; Fig. 7.2). However, it was not possible to expose the entire building in plan; the N side had been destroyed and the remains were also truncated by several service trenches (Jackson *et al*. 1969, 206–8 and fig. 4). The base had been baked hard in patches and there were the remains of charred timbers scattered across it, some of which appeared to be the remains of wooden fittings or furniture. There was a layer of burnt sand above the base of the sunken feature, which was interpreted as the floor but it was unclear whether the layer of sand was 'debris from the collapsed walls or whether it had been thrown over the smouldering beams in an attempt to smother the flames' (Jackson *et al*. 1969, 208). There was a substantial deposit of burnt daub, with timber impressions, immediately above the sand that was presumably the remains of the walls that collapsed inwards. According to the report, this was 'practically filling the hollow by the south-east wall, it then became thinner further from the wall, as if it had fallen inwards at the time of the fire' (Jackson *et al*. 1969, 208). Ten vertical planks were placed at the base and along the S side of the sunken feature, 0.60m apart (centre-to-centre), which had been driven into the subsoil without the need for post-holes. The slots for the planks were *c*.0.25m long (max.) x 0.05m wide. On the E side, the planks were set in post-holes and some of these survived up to 0.25m above the floor (Jackson *et al*. 1969, 208). There was a row of vertical stakes, between or behind these, *c*.0.06m (max.) in diameter, which presumably represented the remains of wattle and daub lining. There was a larger ridge post-hole, for square posts, half way along the E and W sides.

There was evidence to suggest fixed furniture, possibly benches, shelving or beds, along the S and E sides of the sunken feature in the regular arrangement of charred timbers parallel to, and *c*.0.60m from, the walls (Jackson *et al*. 1969, 210 and 214). In the centre, three large planks (the central and largest plank was 0.38m long x 0.06m thick) forming a H-shaped arrangement were set in a large post-hole 0.60m deep. The function of these planks was unclear. Two sub-circular posts (0.23m in diameter) were located to the S of these, 0.75m apart and 0.55m deep. The excavators suggested that these two posts might have been the frame for a loom, with the H-shaped planks forming a seat. However, Myres made the point that no loomweights were found in this area of the building, although several groups of loomweights were found elsewhere in the building, with 30 in four parallel rows close to the E ridge-post and at least 18 in two or three rows in the SW area of the sunken feature (Jackson *et al*. 1969, 214). He also suggested that the substantial size and depth of the post-holes seemed unnecessarily large for a loom and seat.

A large SFB, dating to the 7th or 8th century, was excavated at Old Swindon in 1974 (Canham and Phillips 1976; B. Phillips pers. comm.; Fig. 7.3 and Plate 7.1). The large sunken feature, which measured 8.40 x 4.80m in area x 0.54m deep, was filled with burnt daub containing wattle impressions. This material appeared to be the remains of

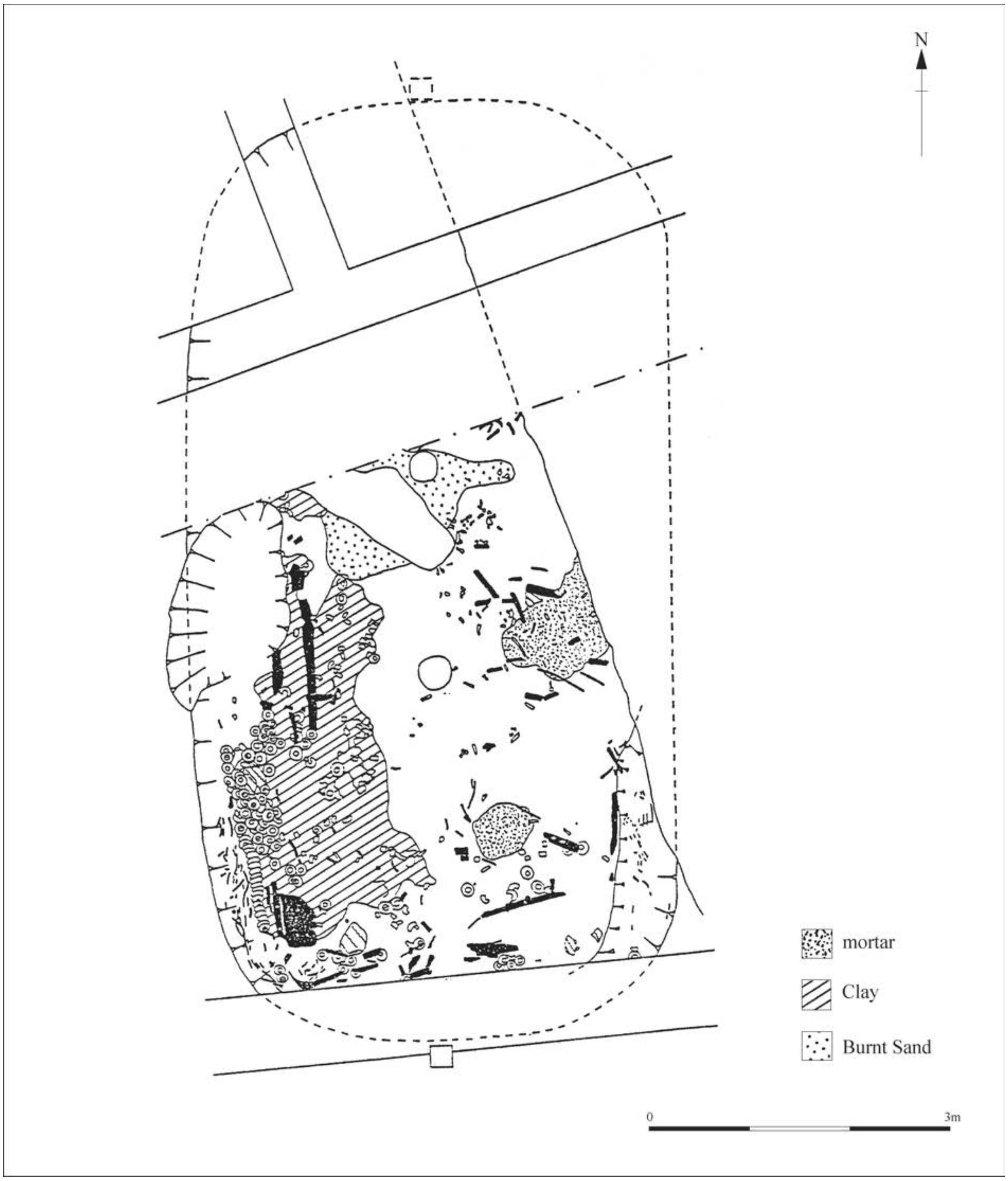


Figure 7.3 Plan of a large sunken-floored building destroyed by fire at Old Swindon. *Courtesy of Bernard Phillips and Roy Canham*

the walling which had collapsed, or had subsequently been pushed, into it. The daub sealed rows of loomweights, and other objects associated with textile manufacture, as well as several pottery vessels, suggesting the building had been used (at least in part) for cloth working. A large sunken-featured building, measuring *c*.7.00m x 4.00m in size, and also destroyed by fire *c*.900 AD, has been investigated in Lichfield (N. Tavener pers. comm.). Like the buildings at Upton and in Old Swindon, it had wattle and daub walls that had collapsed down into the sunken feature.

A large sunken-floored building (N4) destroyed by fire and also dating to the 7th or 8th century was excavated in Dover in 1976 (Philp 2003, 14–25; Fig. 7.4). The sunken feature contained the remains of 28 large planks, with 18 *in situ* set in a shallow trench around the base of the sides. These planks had originally formed walls around the sides of the sunken feature, delimiting an area *c*.7.50m x 3.15m internally. They were preserved up to *c*.0.60m above the base, and individually measured *c*.0.20–0.30m wide (up to 0.41m). There were also the remains of 12 timbers, surviving up to *c*.0.70m long x 0.14m wide, containing sub-circular mortice holes 0.02–0.04m in diameter; it was suggested that the timbers were perhaps part of wattle frames. Six areas of interwoven wattle were found on the base in the N half of the sunken feature.

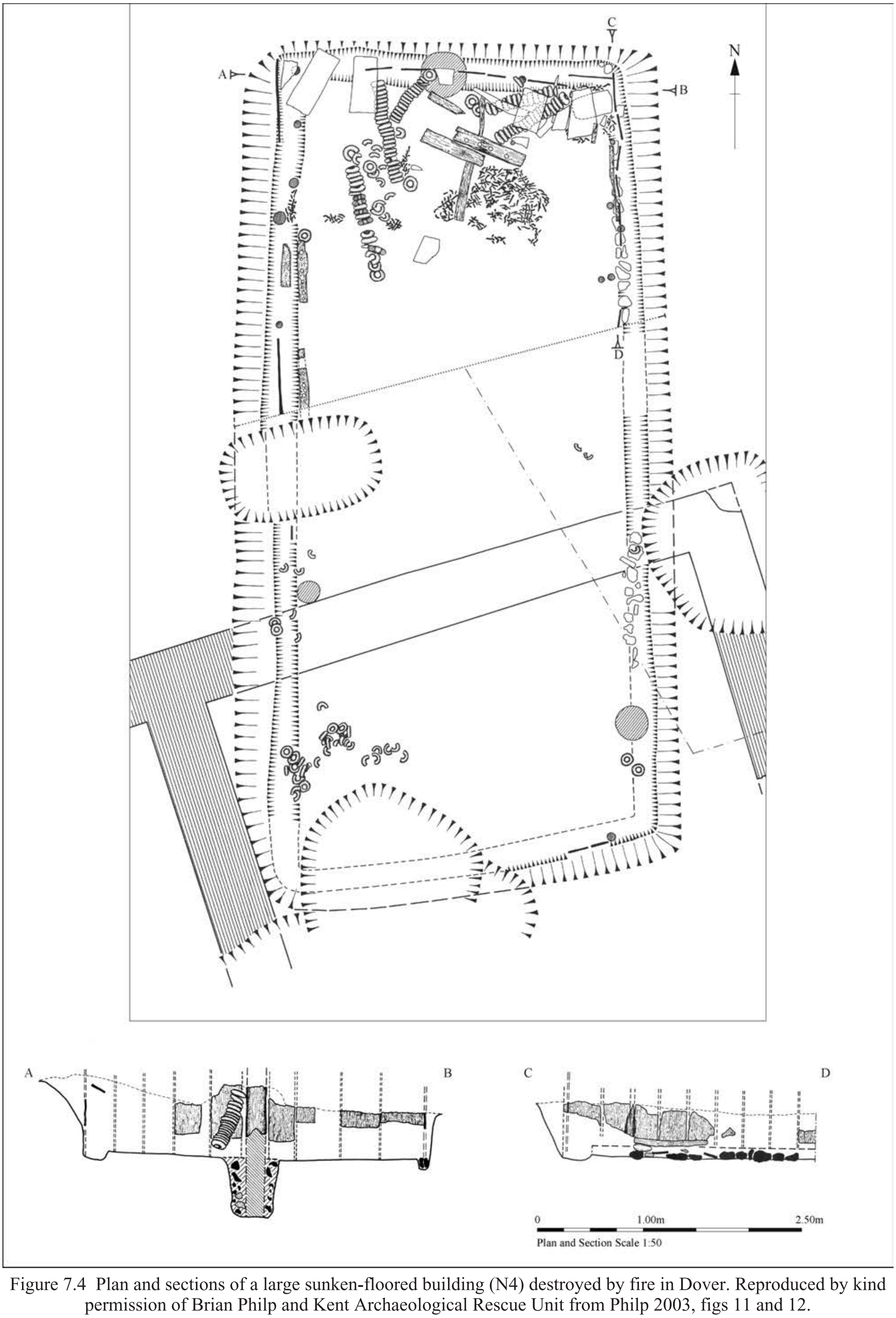


Figure 7.4 Plan and sections of a large sunken-floored building (N4) destroyed by fire in Dover. Reproduced by kind permission of Brian Philp and Kent Archaeological Rescue Unit from Philp 2003, figs 11 and 12.
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A large post-hole 0.45m diameter x 0.55m deep was defined centrally along the N side of, and at the base of, the sunken feature. The *in situ* wall planks butted against the square post and cut through the infilled post pit, demonstrating that the wall planks were inserted after the post. Any opposing ridge-post, along the S side, had been removed by a later medieval pit. Two further post-holes were defined, on the E and W sides. There was no evidence for a laid floor surface and also no evidence of an entrance, assuming the structure had a sunken floor, although the sunken feature was 0.60–0.80m deep.

The fire debris, across the base of the sunken feature, varied from 0.10–0.80m in depth and consisted of black-brown loam containing carbonised wood, burnt clay, daub and small chalk lumps, occasional flints and the finds assemblage. Like the structures at Upton and Old Swindon, there were large quantities of loomweights, many in rows, on the base of the sunken feature. 189 loomweights or loomweight fragments were recovered, with the remains of five rows (139 loomweights) at the N end of the building (which was aligned N–S, like the building at Old Swindon); the longest row, String 1, was *c*.1.10m long and contained 25 loomweights. A scatter of loomweights was also found in the S part of the sunken feature. Other contents were found on the base of the sunken feature, some also related to textile manufacture, including a bronze work-box, part of a bone comb, three spindle whorls and three bronze pins. This layer was sealed by a succession of dumped soils.

The partial remains of a second burnt sunken-floored building (S11), dating to the 9th or 10th century, was excavated in Dover (Philp 2003, 48–51). Stake-holes were defined along the N and W (surviving) sides of this sunken feature with traces of carbonised timbers behind the stakes that are possibly the remains of horizontal planks, held in place by them. A thick layer of loam and burnt daub fragments, up to 0.20m thick, lay across the base of this sunken feature. This material, which presumably collapsed down from the superstructure, sealed occupation material that included 16 loomweights.

These burnt SFBs were, in general, meticulously excavated and recorded using the techniques available at the time. However, the majority were investigated during the 1960s and 70s before the routine application of many scientific analytical techniques, for example environmental assessment, soil geochemical and micromorphological analysis and three-dimensional recording of finds (although the use of these techniques is still not standard on excavations). The evidence from these other examples is drawn upon, where possible, to further the discussion but a detailed re-examination has not been undertaken.

The remains of a heavily truncated SFB (638), also possibly destroyed by fire, were excavated at RAF Lakenheath, Eriswell, Suffolk (Tester 2006). Like SFBs 3 and 15 at West Stow, the sunken feature at Eriswell was also cut into sand. It was probably a two post-hole structure, although only the W end of the feature survived, and measured 3.00m long (min.) x 3.40m wide x 0.80m deep. Similar to the evidence in the base of the Farmer's House, the burnt horizon was *c*.0.20m above the cut of the sunken feature. This unburnt layer was interpreted as a 'trampled working base' (Tester 2006, 17), which presumably formed during construction or use. Based on the assessment report, the burnt layers contained both small and large fragments of burnt wood, as well as fine charcoal and burnt sand. Fifteen fragments of charred wood assessed were all roundwood <0.50m long (Darrah 2006). All but one was <0.06m in diameter; the exception was 0.12m. The species included hazel, willow, ash, field maple and oak (Gale 2006, table 13). Although cereal grains and crop weeds were present in the charred macrofossil assemblage, grasses, grassland herbs and wetland plant macrofossils were predominant, possibly indicating that this material was largely derived from burnt thatch, litter or bedding (Fryer 2006, 41). There were several loomweights from two layers at the interface of the burnt and unburnt layers, with *c*.4.60kg of loomweight fragments in total from this sunken feature (Walton Rogers 2006, 31). Like those within SFBs 3 and 15, the loomweights were partially burnt and unburnt.

There are also several examples of SFBs that contain burnt deposits within their sunken features but which are probably not the remains of buildings destroyed by fire; the burnt material is the result of secondary deposition, burnt elsewhere and subsequently dumped into a disused sunken feature after the superstructure has been dismantled. Two SFBs excavated in 1993 at Hinxton Hall, Cambridgeshire, possessed evidence of burning (P. Spoerry pers. comm.). In particular, one (SFB 2, context 2735) had lines of loomweights and several lengths of charred timber on the base of the sunken feature (Fig. 7.5 and Plate 7.2). According to the site records, the fill was a dark reddish brown sand/silt/clay extending across the whole base of the building pit, varying in thickness from 0.15–0.20m. However, there was apparently no evidence of any burning or scorching on the base itself and the area of burning appeared to be localised. Moreover, the majority of loomweights were unfired.

At Hinxton Hall, the evidence suggests a fire has been lit over the top of the loomweights when there was little opportunity to involve the entire structure. The evidence is indicative of combustion by convection associated with a rich-burning fire, in which the combustion gases have been allowed to escape from the compartment (K. Harrison pers. comm.). It is, therefore, unlikely to be the remains of a building destroyed by fire. In contrast, within the Farmer's House the compartment restricted the release of combustion gases and resulted in a flameover combustion; the gases reignited and caused comprehensive heating to the underlying soils through the action of radiation.

The fill of a sunken feature at West Heslerton (*Grubenhaus* 011AA00005) contained a burnt sand layer, *c*.0.10–0.20m above the base, with the carbonised remains of several substantial timbers (up to 0.35m long x 0.16m wide) (Powlesland forthcoming; D. Powlesland pers. comm.). It is suggested that these carbonised timbers were probably dumped within this sunken feature after it had been already partially infilled, because there were only several charred timbers and they did not appear to form a clear or orderly pattern. Moreover, the sides of the sunken feature (cut into chalk bedrock) showed no evidence of scorching. A large deposit of semi-fired loomweights (an estimated 50 loomweights in total) was also defined at the same level, heaped together, rather than in neat rows, in the NW corner of the sunken feature. These had possibly been destroyed in the same event, and dumped in this disused sunken feature.

There is also a small number of burnt examples from the continent, for example two sunken-floored buildings,

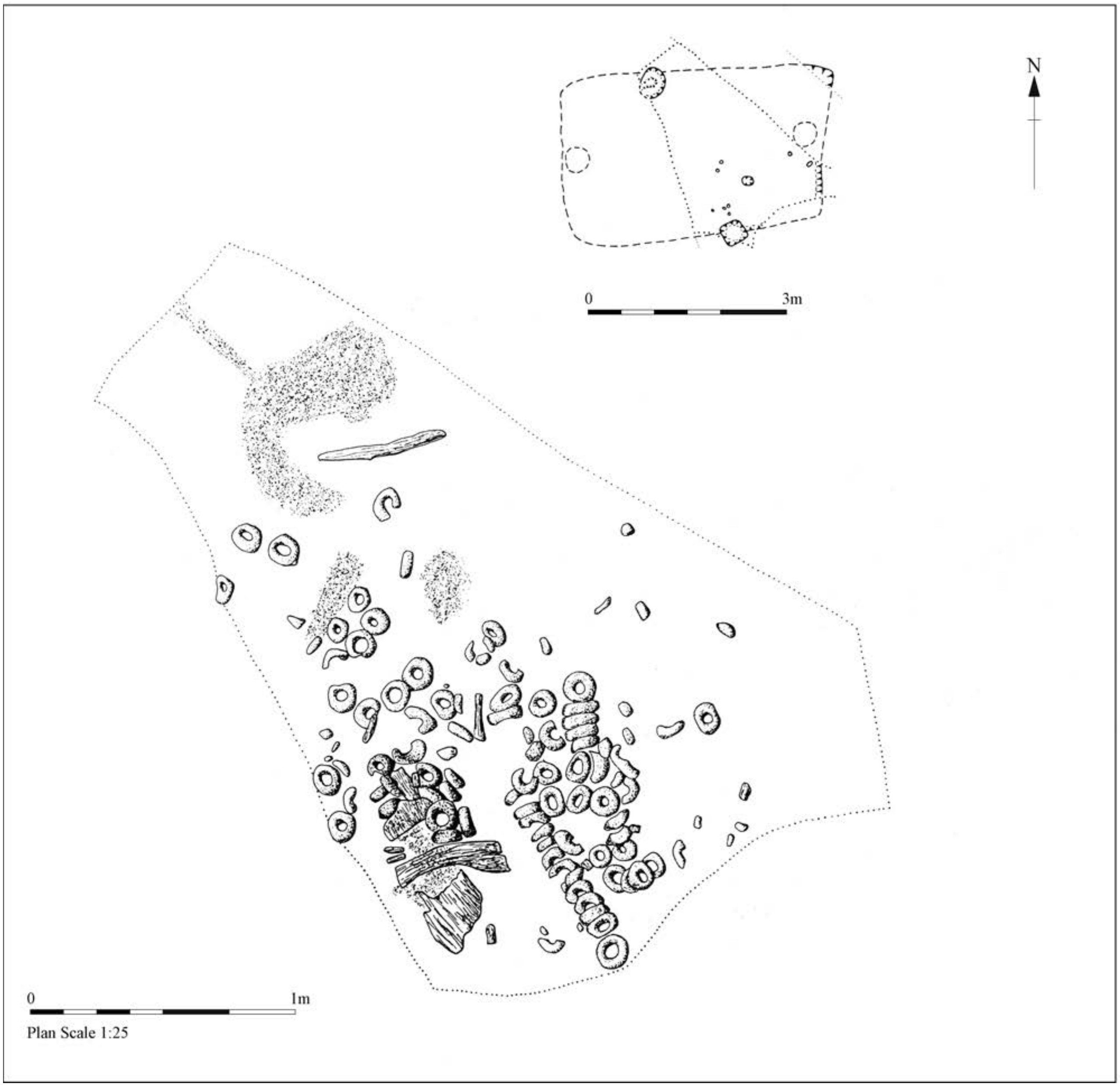

Figure 7.5 Plan of the burnt remains within SFB 2 at Hinxton Hall, Cambridgeshire. *Courtesy of Paul Spoerry and Oxford Archaeology East*

Grubenhäuser 9 and 10, at Dalem in Lower Saxony, Germany, dating to the 11th or 12th century and 8th or 9th century respectively (Zimmermann 1982, 117–26 and abb. 3–10; 1991, 39 and abb. 6) but these are beyond the limits of this current study.

Absence of hearths in SFBs

It is perhaps surprising that the number of burnt examples of SFBs is not higher, given the large number that have been now investigated and given that at least some of the burnt remains from the collapsed superstructure would most likely be preserved on or close to the base of their sunken features had they burnt down. Moreover, it would have been very difficult, if not impossible, to extinguish a fire once it had taken hold given the flammable building materials, with or without the benefit of modern fire-fighting facilities, as the fire at West Stow in September 2004 demonstrated. The small number of burned SFBs, compared to the large number that have been investigated, suggests they were not intentionally destroyed, for example, as part of some ritual abandonment behaviour; otherwise we might expect to find more examples of burned buildings, even if it was rare in the lifetime of most individuals (see above).

The lack of fires was perhaps due to diligence of the occupants, not leaving fires unattended and careful maintenance of hearth bases. It is possible, however, that the majority of SFBs never actually had hearths, if they were workshops and stores, rather than dwellings (Rahtz 1976, 76). In medieval vernacular buildings, for example, the open hearth was generally confined to the central hall; workshops and service rooms lacked hearths and any form of heating (Alston 2004). This might explain the scarcity both of burnt examples and of substantive evidence for internal hearths, although hearths on the base of sunken features have been argued in a number of examples (Tipper 2004, 89–92). Neither of the two burnt examples at West Stow contained definite evidence for hearths,

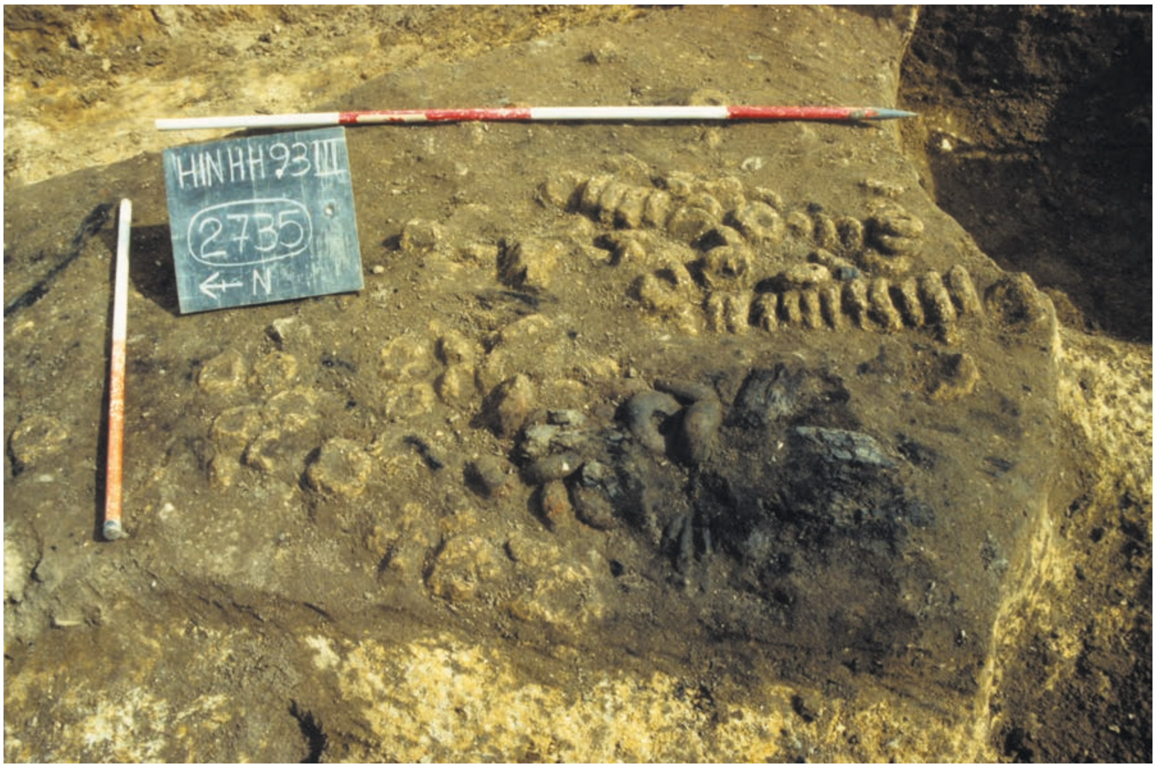

Plate 7.2 The burnt deposit on the base of SFB 2 at Hinxton Hall, Cambridgeshire (viewed from W; scale at 0.50m intervals). The burning is localised and the majority of loomweights, and soil matrix, are entirely unburned.
Courtesy of Paul Spoerry and Oxford Archaeology East

either a hearth *in situ* on the base of the sunken feature (set directly on or into a sunken floor) or one that had obviously collapsed down from above. There was, however, a patch of burnt clay on the edge, and in the SW corner, of SFB 15 (West 1985, fig. 71). West interpreted this deposit as a hearth within the original building, which presumably was on the planked floor that collapsed down during the fire (West 1985, 23). The original function of this clay is unclear and rather than a hearth it could possibly be the remains of a deposit of clay for making loomweights. Similarly, there was no evidence of a hearth within Building C1 at Yeavering or within the burnt building at Upton, which were interpreted as sunken-floored buildings by their excavators (see above). In comparison, the relatively well-preserved floors levels of the Middle Saxon buildings at the Royal Opera House, London, had well-defined internal hearths, ovens and fireplaces (Malcolm *et al*. 2003, 155). Had SFBs also possessed hearths on the base of their sunken features, we should expect these to have been well-preserved and unequivocal.

Burnt features interpreted as hearths by West were defined at the junction between the lower fill and the upper cultural layer (Layer 2) in ten SFBs (West 1985, 120). In particular, large burnt clay hearths in SFBs 44 and 49 were located, he suggested, 'in such a position that they must have been supported over the pit, to account for their subsequent partial collapse on to the top of the primary fill' (West 1985, 120). It is possible, however, that these substantial features might be later oven bases, based on their structural form, set within the hollow after the infilling and stabilisation of the sunken features after the original buildings had been abandoned (Tipper 2004, 90–2). Similarly, a number of the other burnt clay deposits interpreted as hearth bases at West Stow might have been little more than secondary burnt clay deposits.

Late Saxon and early medieval cellared buildings

There is a small number of late Saxon and early medieval cellared buildings that are structurally comparable to the Farmer's House, in so far as they had timber-lined cellars. However, they also have some significant differences. In particular, many possess stepped entrances and the cellars generally have closely spaced posts around all four sides, rather than the two or six large posts found in earlier SFBs.

Seven late Saxon cellared buildings destroyed by fire have been excavated in Ipswich, one dated to the early 10th century and six to the late 11th century (Wade 1994; K. Wade and T. Loader pers. comm.). This type of cellared building has not been found in contemporary rural settlements, and it would appear to be a specific response to the use of space within towns. It is also different from the typical early Anglo-Saxon SFB (Tipper 2004, 13–4). However, this type of building does possess structural similarities to the Farmer's House, in that both were timber-heavy with lined cellars of a similar size and depth, employing substantial, horizontal planks, substantial posts and planked floors. Therefore, it might be expected that these buildings would have responded in a similar manner during destruction by fire.

In IAS 3104 Building 2140 (IAS 3104, St Stephen's Lane), dated to the late 11th century, the vertical posts were preserved up to *c*.0.90m high above the cellar base, which measured 1.20m deep (Fig. 7.6, Plates 7.3 and 7.4). The lower part of the cellar lining also survived and in places the charred remains of the two lowest planks survived (with the base of the third) *c*.0.80m high (max.). The building had two phases: the first measured 5.10 x

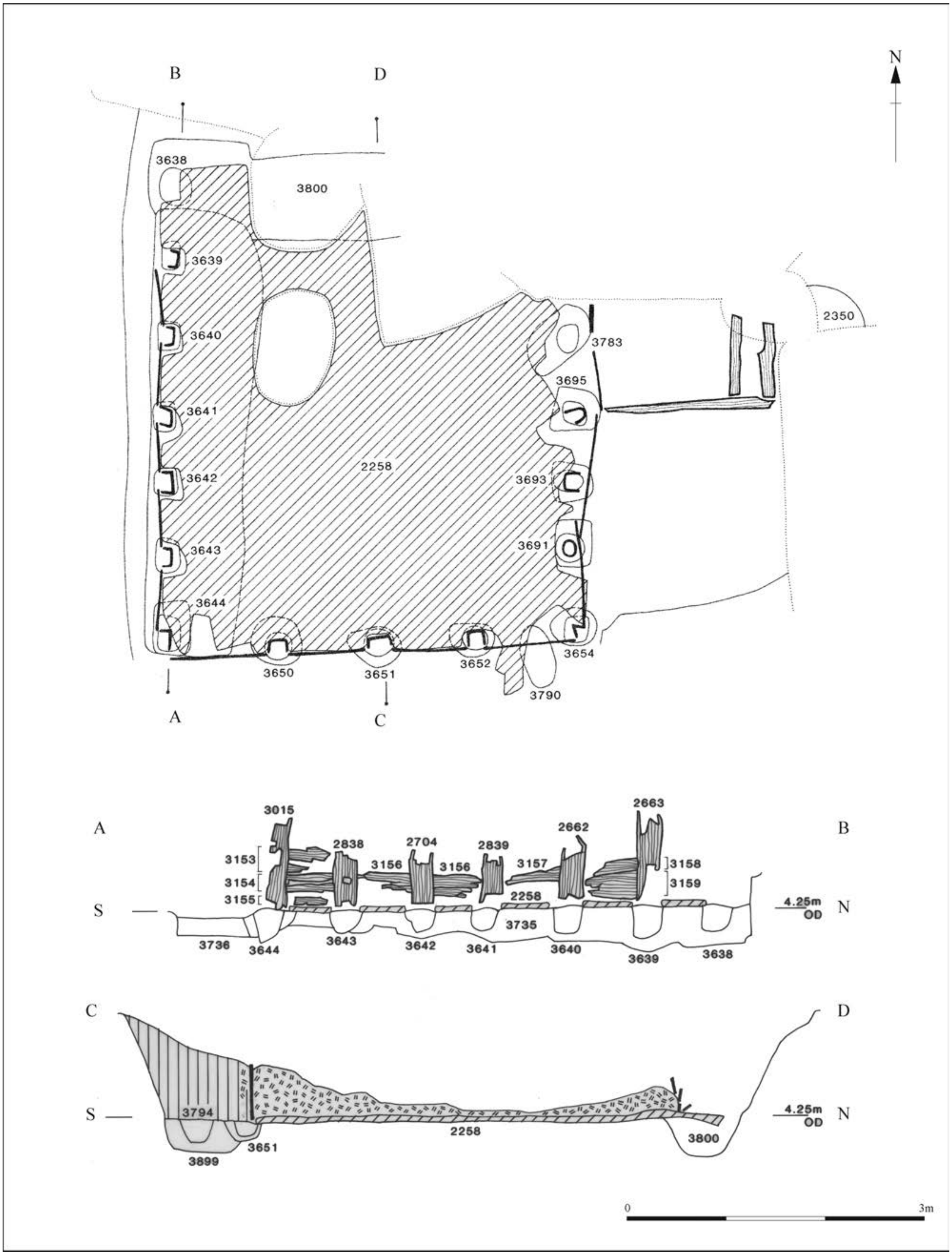

Figure 7.6 Plan and section of an 11th-century cellared building destroyed by fire from St Stephen's Lane, Ipswich (IAS 3104, Building 2140). *Courtesy of Keith Wade and the Archaeological Service, Suffolk County Council*

Plate 7.3 Building 2140 from St Stephen's Lane (IAS 3104), Ipswich (viewed from NE; scale at 0.50m intervals). The image shows the cellar after excavation and removal of the charred debris (and later infill) with the *in situ* charred posts and plank lining clearly preserved along the W and S sides. The entrance was on the E side of the cellar. The N part of the cellar has been cut by a number of later pits. *Courtesy of Keith Wade and the Archaeological Service, Suffolk County Council*

Plate 7.4 Building 2140 from St Stephen's Lane (IAS 3104), Ipswich (viewed from NE; scale at 0.50m intervals). Detail of the *in situ* charred posts and the lowest two planks of the cellar lining (wedged behind the posts) preserved in the SW corner of the cellar. The post and plank surfaces survive as thin veneers of charred material on the three outer facing sides. *Courtesy of Keith Wade and the Archaeological Service, Suffolk County Council*

4.40m in area, but the building was foreshortened in the second phase (T. Loader pers. comm.). Charred posts were defined around all four sides of the cellar, with the charred horizontal plank lining wedged behind the posts, which had been inserted into foundation slots or trenches (i.e. post-in-trench construction) *c*.0.30–0.65m deep (max.) around the base of the pit. All the posts were square or rectangular, spaced *c*.0.70–1.00m apart centre-to-centre and individually measuring *c*.0.20 x 0.14–0.16m in size while the boards lining the cellar were *c*.0.25–0.30m wide.

Like the evidence from the Farmer's House, however, the surviving timbers were only partially charred; the outer faces of both the posts and planks had been charred but their interiors were not and these had subsequently rotted away to be replaced by soil. The charred remains of some structural timbers were preserved on the base of the cellar, although clearly the majority of timbers did not survive in the archaeological record. Presumably, they had been either completely destroyed or they had remained uncharred and rotted away; some may have been salvaged. In addition, some of the contents of the building, and also fixtures, were preserved on the base of the cellar. These included four pottery vessels and a lamp, a turned wooden vessel, a wooden barrel containing oat/barley malt and also a basket with oat malt, 18 bread loaves, and over 250 iron objects (Murphy 2004; Wade 1994).

Building 677, from Foundation Street (IAS 4601), also produced evidence of charred horizontal oak boards along all four sides of the cellar, again behind vertical oak posts and with charred pegs that presumably held them in place. There were also the remains of at least four collapsed planks, lying roughly horizontally *c*.0.60m above the cellar floor, that are presumably the remains of the collapsed floor or possibly the remains of walling that collapsed inwards. In addition, there was a large quantity of burnt clay or daub (over 200kg), which had collapsed down into the base of the cellar, within the layers of charred structural remains; there were also large quantities within several other cellar-buildings that were destroyed by fire. The clay is perhaps the remains of a hearth constructed on the suspended wooden floor or possibly the remains of daub used to infill the walls (T. Loader pers. comm.).

IV. The evidence of burnt ground-level buildings

The scarcity of examples of burnt ground-level buildings, i.e. earth-fast wall-post buildings, can be explained more easily in terms of formation processes, given the general absence of surface deposits from most, and especially rural, sites that have been excavated, due to later truncation. In addition, the evidence from burnt experimental reconstructions demonstrates that posts will not normally burn below ground in their post-holes (see below).

The distribution of burnt Early Iron Age long-houses in Denmark, where a large number of burnt buildings have been investigated, is instructive in this argument. In Denmark, there is a clear predominance in NW Jutland compared to elsewhere (Bjarke Christensen *et al*. 2007, 58 and fig. 21). The quality of evidence is exceptional from some of these sites. At Nørre Tranders, for example, the remains of 19 burnt buildings (out of 157 in total) have been investigated (Nielsen 2007). The burnt house A371, excavated in 2000–1 and dating from the end of the Pre-Roman Iron Age, had a burnt layer only several centimetres thick across the living quarters (W end) but the layer was *c*.0.25m thick at the opposite byre end. It has been suggested that the remains of the living end had been cleared away after the fire, indicated by the lack of artefacts in the remains and shallow depth of the fire layer across that end of the building, compared to the opposite end (Nielsen 2007, 19–20). The byre end of the building contained the burnt remains of people and stalled animals: five people, five sheep, two horses, seven cattle, a suckling pig and a puppy (Nielsen 2007, 23–25 and figs. 4–6). It seems likely that the people found here were trying to save the animals from the fire, which was presumably accidental, or possibly that some might have been asleep in the byre (Nielsen 2007, 29).

While there are a number of possible explanations for the marked distribution, the most obvious explanation is because 'the large part of Jutland where the burnt houses are found has lain heath for centuries', i.e. it is a consequence of better preservation (Bjarke Christensen *et al*. 2007, 60). It has been suggested that the small number of burnt buildings from Zealand, in comparison, 'can perhaps be explained in terms of the fire layer having been ploughed off by intensive agriculture' and it can, therefore, be difficult to recognise burned houses when the occupation surface has been destroyed (Bjarke Christensen *et al*. 2007, 60). Similarly, this argument might be equally applied to England. In general, on most excavated sites in this country (of this and other periods), the contemporary ground surface has been completely destroyed by later, intensive agriculture leaving only negative or cut, subsurface features. Therefore, it is reasonable to assume that most, if not all, of the surface deposits would have been lost, unless there were exceptional circumstances, making interpretation that much harder. The only evidence, for example, to indicate that an early Iron Age building had been destroyed by fire at Brighton Hill South, Hampshire, was the presence of vitrified pot-sherds within the post-holes (Coe and Newman 1993). There was no evidence of charcoal in the post-holes, however, which are comparable in size to post-holes found in early Anglo-Saxon wall-post buildings, 0.20–0.40m in diameter x 0.15–0.35m deep. In the discussion of the evidence from Brighton Hill South, comparison was made to an experimental roundhouse fire at Bromsgrove where the fire had had little effect on the daub walls or the timbers in the walls, which were re-used for another structure (Coe and Newman 1993, 24). Consequently, it was suggested that any burnt surface debris and undamaged components had been removed and cleared away before the deposition of the pot-sherds in the post-holes, which must have been part of the final clearance into the nearest post-hole and possibly part of a symbolic act.

It also seems likely that the high level of preservation in Denmark is due to the type of construction. In NW Jutland, turf was widely used for building, with 'metre-thick turf walls that, after the fire, [were] levelled out over house remains' (Nielsen 2007, 17–20). This, combined with continued rebuilding and occupation on the same site, has led to the build up of deposits and the formation of settlement mounds and therefore high levels of preservation at least within the lower levels of settlement mounds. At Nørre Tranders, for example, there was a stratigraphic sequence over 2.00m deep with up to 13 phases (Nielsen 2007, 18). Construction on the same site, however, can lead to considerable destruction and truncation while later agriculture has often destroyed the upper levels.

Contemporary with the early Anglo-Saxon period, dating to the 6th century AD, a (ground-level) burnt house (*Brandhuset*) was discovered in 2007 at the central place of Uppåkra in S Sweden (Herschend 2009). Similar to Nørre Tranders, there was a complex sequence of occupation layers up to 2.00m deep on the site (Larsson and Lenntorp 2004, 3–4). There were 'at least three slain or wounded persons' within the building remains of the burnt house and 'many more people in and around this house' (Herschend 2009, 375). Like Nørre Tranders, the remains of the people were 'left exposed for everyone to see and contemplate' (Herschend 2009, 375). Perhaps the destruction was a ritual or symbolic act, or simply the result of hostility. However, at Nørre Tranders it has been suggested this was probably simply due to the fact that the remains were very fragmentary and therefore they were not cleared away (Nielsen 2007, 29).

There are several examples of burnt ground level buildings in England, from Cowdery's Down, Yeavering and London, although the evidence is not generally of the same quality. In the case of the two rural sites, it is perhaps not coincidental that both are at the highest level of society; the evidence is from large buildings with substantial below-ground structural features that acted as artefact traps. At Cowdery's Down, the largest building C12 produced evidence to suggest it had burned down (Millett and James 1983, 217 and fig. 66). However, the only evidence for the fire was preserved in a shallow gulley along the inside of the wall line, which contained a large quantity of burnt daub and charcoal. The gulley survived only in one area of the building where there was little plough damage.

The royal palace at Yeavering produced evidence of large timber halls defined by substantial post-holes and foundation trenches (Hope-Taylor 1977). Hope-Taylor defined at least two major conflagrations based on charcoal, charcoal-blackened soil, fire-cracked pebbles and burnt daub (often in dense, linear concentrations) in refilled post and plank sockets, either in the sockets of the former timbers, the demolition trough or secondary packing soil (1977, 34–45, 163–6 and fig. 10). The buildings of Phase IIIc and Phase IV were destroyed by fire and Hope-Taylor suggested both events were the 'result of a calculated act of hostility' (1977, 163), which he linked to historically documented events recorded in Bede's *Historia Ecclesiastica* (1977, 177). In terms of the physical evidence, with a few exceptions, there were no surface remains due to later truncation. It is also possible that burnt remains were cleared away to allow re-building, often on the same footprint. According to Hope-Taylor (1977, 43), 'the process of structural demolition had allowed large samples of the overlying debris to fall into the sockets of newly withdrawn timbers'. The evidence was identified at Yeavering because of the substantial size of the wall foundation trenches that acted as artefact traps (the timber thickness in Phase IIIc was *c*.0.14m; Hope-Taylor 1977, fig. 70), also because of the number of successive phases of re-building, combined with detailed recording and interpretation.

In general, however, most Anglo-Saxon ground level buildings are defined by much smaller post-holes that are not good artefact traps. One or more subtle lenses of charcoal in the fill of the post-holes, on comparison with the evidence of the post-holes associated with SFBs 3 and 15 at West Stow, might be the only evidence to indicate a ground level building had been destroyed by fire. It is, therefore, important that post-hole fills of buildings are bulk sampled and assessed for charred environmental remains to recover this evidence that might be otherwise entirely overlooked, especially on rural sites where surface deposits have been often destroyed by intensive agricultural regimes (and subsequently machine-stripped during archaeological investigation).

The partial remains of a Middle Saxon building destroyed by fire were excavated at Congham, Norfolk, in 1971 (Webster and Cherry 1972, 154; K. Wade pers. comm.). The site of the building (at first thought to be a kiln or oven) was located after the field had been deep-ploughed in 1970, which brought a concentration of burnt daub and other material culture to the surface of the ploughsoil. The plan of the building, which measured *c*.5.50 x 4.00m in size, was defined by a line of five post-holes down the centre of an area of dark soil and occupation debris with a possible hearth of ash and burnt sand at one end. These were sealed by a large quantity of burnt and wattle-marked daub.

In London, at the Royal Opera House site, in almost every case, the Middle Saxon buildings were partially sealed by a horizon of charcoal or ash and often with a layer of burnt daub from collapsed walls, which indicates they were destroyed by fire (Malcolm *et al*. 2003, 156). The frequency of the burnt evidence suggests that fires were also commonplace in Anglo-Saxon towns where, as in later medieval towns, the buildings were tightly packed together. In comparison, in earlier Anglo-Saxon settlements, at least, buildings were generally dispersed and unbounded (Hamerow 2010, 9–10). As a result, the risk of accidental fire spreading between buildings would have been significantly lower.

The preservation of surface deposits at the Royal Opera House site has resulted in a more detailed level of information about the destruction of these buildings, compared to those at Cowdery's Down and Yeavering. One of the most complete, Building 27 (Period 5, dated *c*.730–770), had earth-fast wall-posts 1.20–1.40m apart with a wattle and daub wall attached to the outside face of the posts, which survived partially intact to a height of 130mm (Malcolm *et al*. 2003, 73–5 and fig. 65). Finds from the building included 71 loomweights, a bone thread picker and a spindle whorl showing that textile production took place in the building, as well as some evidence for small-scale metal-working. A barrel padlock was found on the floor of one room, probably used to secure a chest (Malcolm *et al*. 2003, 74–5 and fig. 67). In Building 37, within the same phase and also destroyed by fire, a row of ten burnt and fragmentary loomweights was recovered from the destruction horizon within the building (Malcolm *et al*. 2003, 85 and fig. 75).

V. The evidence compared

The total surviving and identifiable remains of the Farmer's House (excluding the thatch) is calculated very roughly at *c*.17%. The estimate for that part of the structure above floor level (i.e. excluding the suspended floor and cellar lining) is significantly lower at just *c*.6%[iv]. It varies from *c*.11% for the walls (*c*.25% for the W wall but only *c*.2% for the N wall) to 0% for the tie beams (Table 3.2).

It is surprising how much of the superstructure was destroyed. With the exception of a single piece of door-post within the pit, and the *in situ* posts, all the identifiable remains of the superstructure (again, excluding the floor and cellar) were from the ground surface and had fallen outwards. There was evidence for the remains of the walls, in the form of (sections of) charred and/or partially charred wall boards, which had collapsed outwards from the building onto the surrounding ground surface. No wall boards were identifiable within the internal area of the building. However, the images of the fire clearly show that most of the frame simply collapsed vertically as evidenced, for example, by the N purlin that can be seen straddling the cellar pit (Plates 3.1–3.4). The majority of the superstructure was turned to ash within the pit. There was, however, a mass of unrecognisable material within the pit from the superstructure.

In comparison to the above-ground building, *c*.50% of the cellar lining survived the fire and it is also perhaps surprising how much of the cellar was preserved given the great intensity of the fire within the pit (Chapter 6).

In the following section, the evidence from the Farmer's House discussed in detail in Chapter 3 is summarised. Comparison is made to the archaeological evidence and the implications for the archaeological record are discussed.

The organic constituent

With a small number of exceptions, notably the surviving floor planks on the base of the cellar (see below), the surviving timbers of the Farmer's House were superficially charred. In most cases, the timbers possessed only a thin outer layer of charred material, although the heat-transfer process was increased at the corners, resulting in an increased depth of char and rounding at corners. However, timber is a non-homogeneous and variable material, and the rate of charring depends on density, moisture content and permeability.

It is reasonable to suppose that, had the remains been left *in situ* for any length of time, the charred outer layer would have fragmented away from the inner, uncharred parts of the surviving timbers. This is because the thermal conductivity of wood is low, resulting in a very clear interface zone between charred and uncharred sections of timber (Shields and Silcock 1987, 242). In the five month period between the fire and excavation, the charred outer layer on most boards had started to fragment and split off along the medullary rays of the timber, caused by weathering, insects and vegetation recolonising the site, and other agents of decay, exploiting the cracks or fissures in charred material. This process was more evident in the charred remains collected and stored in an exposed area during the following winter (Plate 7.5). These timbers had been almost completely buried by vegetation, making them almost invisible. When they were removed the following spring the charred outer layer on the underside of the timbers was left embedded in the ground while the upper charred surface had also flaked away from the uncharred timber.

Many of the observations regarding the Farmer's House made in Chapter 3 have relied upon the survival of an organic constituent: the actual wood on which light charring is preserved. Once the organic constituent has decayed, the proportion of identifiable remains would be significantly reduced. With time, the uncharred parts of the surviving timbers will have decayed (perhaps more slowly than uncharred timber because of the protective quality of the char layer; see below) leaving only a thin layer or lens of charred material for each, unless the unburnt timber was replaced with humic soil (but this presupposes they were buried), rather like the decay of a post. The evidence from SFBs 3 and 15, for example, was reliant entirely on the charred element; any organic constituent that might have survived the fire has long since decayed.

In the archaeological record, it seems unlikely the surviving remains would be identifiable as the remains of specific timbers, whether or not they had remained *in situ* where they fell (see below)[v]. The remains of the wall boards that fell outwards would survive only as a thin discontinuous layer of charred material, if at all, again assuming they were left *in situ*. It seems very unlikely that the partially charred tenons from the W ridge- and NE corner-posts would still have been recognisable after decay of the unburnt part. Similarly, all the surviving roof fixings (with the exception of the charred thatch; Chapter 5) were uncharred or partially charred and they would not, therefore, survive or be recognisable as such in the archaeological record. Within the pit, the charred elements of the cellar planks might survive, *c*.0.03m thick (max.), which is half their original thickness. They would, therefore, be completely misleading about the size of the original timbers, unless the ghost of the other half survived. As with all the other partially charred timbers, the unburnt part of the boards that lined the cellar, and which survived the fire, would have completely decayed with time.

The surface evidence

An occupation surface (Layer 2) was preserved across the site at West Stow (West 1985). However, no burnt remains were defined on the ground surface around either of the two burnt SFBs, with the exception of an area of burnt clay that partly overlaid the edge of SFB 15 interpreted as the remains of a hearth (West 1985, 23 and fig. 71; see above). There was also no evidence of burnt ground, for example indicated by soil discolouration, around the two SFBs. In fact, there was very little evidence for structural remains around any of the sunken features even though these areas were carefully cleaned and excavated in an attempt to define them.

All the burnt remains, in both SFBs 3 and 15, were contained within the base of their sunken features. The evidence suggests they were both purposefully infilled and not left to fill up naturally (see below). They may have been backfilled quickly so that the areas could have been re-used. There was nothing to suggest that any burnt remains on the surface had been subsequently pushed into the sunken feature, either on top of the material that collapsed directly during the fire or within the later fill.

In the case of the later medieval cellared buildings at Pottergate, Norwich, destroyed by fire in 1507, there was evidence to show that the remains had been disturbed and robbed in antiquity (Evans and Carter 1985). In cellar 65,

Plate 7.5 A (partially) charred board from the cellar lining, photographed over two years after the fire in March 2007, after removal from the excavation and laid on the ground surface around the excavated cellar pit (and fenced off). It was the lowest board, which remained *in situ*, along the S side of the cellar. The uncharred area on the right side was protected behind the SW corner-post while the lower part of the board was protected by accumulation below the suspended floor (two slight ridges are also just apparent). Notice how grass has begun to colonise the cracks

there was a thin layer of ash and charcoal on the base, interpreted as the remains of a thatched roof, below a dirty yellow sand layer (Evans and Carter 1985, 13–4 and fig. 4 S1.1). Above this, there was a second thicker layer of ash and burnt daub that 'must represent the deliberate tipping or pushing into the cellar of fire debris after it had become unroofed, and after wind and rain-washed deposits had accumulated over the primary destruction level (Evans and Carter 1985, 13). This layer was below dumps of brick and mortar fragments, representing pushing or tipping of post-fire debris and interpreted as the by-product of robbing parts of the house (behind which the external cellar was located) that survived the fire. Although this example is considerably later and from an urban context, and the cellar (*c*.1.00m deep) had flint rubble and mortar walls rendered in mortar (scorched from the fire), it does help to show the type of activities that might have taken place after such a fire, and the sort of evidence that should be expected (although hard to define) within earlier SFBs and cellared buildings. Similarly, at 13–21 Eastcheap, London, the 600mm thick burnt horizon of timber buildings from the Hadrianic fire of *c*.AD125 had a low number of roof tiles which suggested 'the debris may have been sorted for the salvage of building materials' (Blair and Sankey 2007, 57).

The burnt remains of the Farmer's House were spread across a considerable area beyond the footprint of the original building. There is a strong likelihood, however, within an occupied settlement that surface remains would have been removed had a building been destroyed by fire (although at both Nørre Tranders and Uppåkra the remains were apparently left where they had fallen; see above), unless perhaps the event marked a ritual destruction of a building or an act linked to site abandonment. The remains might have been pushed into the pit, or removed entirely. At Mucking, for example, the destruction debris from a burnt building dating to the 2nd century AD was re-deposited within the upper fill of a well (Well 4) (S. Lucy pers. comm.). It is suggested that the burnt assemblage derived from a building 50.00m away from the well, which represented the nearest convenient hollow into which the material could be dumped.

Charcoal and any re-useable timbers might, but not necessarily, have been reclaimed. At least, it seems unlikely that most of the surface remains would have remained where they had fallen, and this would make the identification and interpretation of the remains even more complex and challenging. In most cases, however, certainly in rural contexts in England, the ground surface has more often than not been truncated and any surface remains, and also shallow buried remains, have been entirely destroyed so it is only possible to speculate about what might have been.

The roof

There were considerable heaps of charred thatch immediately after the fire along the N and S long sides, and outside the wall line of, the Farmer's House, where the thatch (on at least the lower part of the roof) had simply slipped off the roof and burned on the ground. These had been reduced to thin layers by the time of the excavation, and in places the ground was virtually bare where the ash had disappeared altogether. Some better preserved thatch material was, however, preserved below wall boards, which had collapsed onto the heaps of thatch and protected these small areas from later degradation. Elsewhere on the surface, plant re-colonisation was noticeable in several other parts. Furthest away from the fire, there were also several piles of uncharred thatching straw, on the surface around the corners and well outside the wall-line.

No material was identifiable as charred thatch in the pit, either immediately after the fire or during excavation. However, cereal remains were the most numerous charred plant macrofossils (after charcoal and wood) recovered from the flotation samples (Chapter 5). It seems likely that much of the thatch would have dropped straight down into the building, presumably onto the suspended floor which remained in place until after the roof and walls had collapsed. The thatch had, therefore, been completely destroyed during the fire. There was also no evidence of any rafters, batons or twine fixings within the pit. There were the remains of several rafters, a small number of hazel batons, and several short lengths of tarred twine, all on the surface outside the original wall line of the building. However, all the surviving fixings were only partially charred and, therefore, these would not be preserved in the archaeological record.

Evidence of the charred roofing materials (or, at least, interpreted as the remains of roofing material) was found surviving within the sunken features of both SFBs 3 and 15, although no environmental analysis was undertaken on the charred deposits (for example to ascertain the thatching material). It seems likely that roofing material would have been defined in both had samples been taken for detailed analysis. In SFB 3, small charred timbers on the base of the sunken feature, but above the lowest layer of charred planks, were identified as possibly the remains of purlins or rafters (West 1985, 16). According to the report, 'fragments of hazel sticks [up to *c*.40mm in diameter], apparently interlaced, were found all over the SFB, lying on the loomweights and associated with occasional patches of carbonised thatch' (West 1985, 16). The charred hazel sticks were interpreted as the remains of the supports for the thatch, which had presumably been fastened using organic fixings that were completely destroyed. These were sealed by further charred planks, interpreted as the remains of walls 'being the final parts of the burnt SFB to collapse over the remains of the roof, furniture and floor' (West 1985, 16). Similarly, in SFB 15, the loomweights were lying below 'quantities of fragments of small hazel sticks [up to 0.15m long], concentrated mainly around the edges of the SFB' (West 1985, 23). Again, these were interpreted as the remains of the roof fixings, sealed below the upper layer of planks, which were interpreted as the remains of wall planks that collapsed inwards after the roof had been destroyed.

Within Ipswich, however, there was no evidence of any thatch within the charred remains preserved on the base of any late Saxon cellared buildings (T. Loader pers. comm.). This has led to the suggestion that the roofs of the buildings were covered with shingles rather than thatch. Charred thin radial boards or staves of ash 4–7mm thick that might be the remains of shingles were recovered from Building 677, although it was suggested these were probably from a wooden container, such as a barrel or bucket, but there were also some thicker fragments from oak staves 7–15mm thick (Murphy 2004). Similar charred stave fragments were recovered from some of the other cellared buildings, also destroyed by fire. Radially cleft roof shingles have been recorded from late Saxon London at the UPT90 site (Goodburn 1994, fig. 7), and several examples come from Middle Saxon London at the Royal Opera House site (Malcolm *et al*. 2003, 152–3). However, carbonised straw from the remains of several buildings destroyed by fire on the latter site (from Building 27, in particular), also suggests thatch as the roofing material (Malcolm *et al*. 2003, 73 and 152–3).

In Ipswich, it is also possible that the thatch was completely destroyed in the fire. Similarly, much of the thatch, from the lower part of the roof, may simply have slipped off the roof and onto the surrounding ground surface. Charred remains of hazel twigs 10–30mm in diameter, which appeared to be the remains of wattling, could possibly be from roof supports but they were not across the entire base and (probably) not in a sufficiently high quantity. Again, many may simply have been completely destroyed. Alternatively, they could be the remains of internal panels or walling, or possibly the remains of kindling (Murphy 2004). Charred fragments of ash branches *c*.100mm in diameter could possibly be the remains of rafters, but equally they could be from another part of the superstructure or from a fixture or fitting.

Evidence of the frame

There was very little surviving evidence of the frame from the Farmer's House. Similarly, there were no identifiable remains of the supporting framework in either of the two burnt SFBs at West Stow, with the exception of several small fragments in SFB 3 that were interpreted as the possible remains of purlins or rafters (West 1985, 16). It is likely these timbers were also completely destroyed during the fire, or they might have been only partially charred (and the organic component has subsequently decayed). Alternatively, it is possible that surviving timbers were removed from the site.

Evidence of walls

Two layers of planks were identified across the base of the sunken features in both SFBs 3 and 15 with a number separated by deposits of loomweights (West 1985, 119–20 and fig. 71; Chapter 1). The lower layer of charred planks was interpreted by West as the remains of the collapsed suspended floor (see below). He suggested the upper layer was the remains of the vertical side walls that had collapsed inwards and downwards onto the collapsed floor (Figs 7.7 and 7.8). Their alignment and orderly arrangement suggested they had not been dumped in from elsewhere and that they had simply collapsed down into the base of the sunken feature.

In SFB 15, which contained the best preserved evidence, West interpreted six of the charred planks as the remains of wall boards and 11 as the remains of floor planks (1985, fig. 71; Fig. 7.7). The longest fragment identified as a wall board measured *c*.1.90m, although three were over 1.00m long[vi]. The widest plank measured 0.30m wide (although the majority measured 0.24m)[vii]. This measurement is taken as an order of magnitude for the width of the planks, although there was almost certainly variation, which gives an area of surviving walling measuring 2.03m^2 in size.

All but one of the planks identified as wall boards were aligned N–S across the sunken feature, suggesting to West that they derived from the N and S side walls. There was no evidence for the collapsed E and W end walls in the sunken features of both SFBs 3 and 15. These walls could have been totally destroyed or it is possible the boards were not charred sufficiently to survive in the archaeological record, like the boards from the Farmer's House that were only partially and superficially charred. Alternatively, it is possible that the end walls of both SFBs

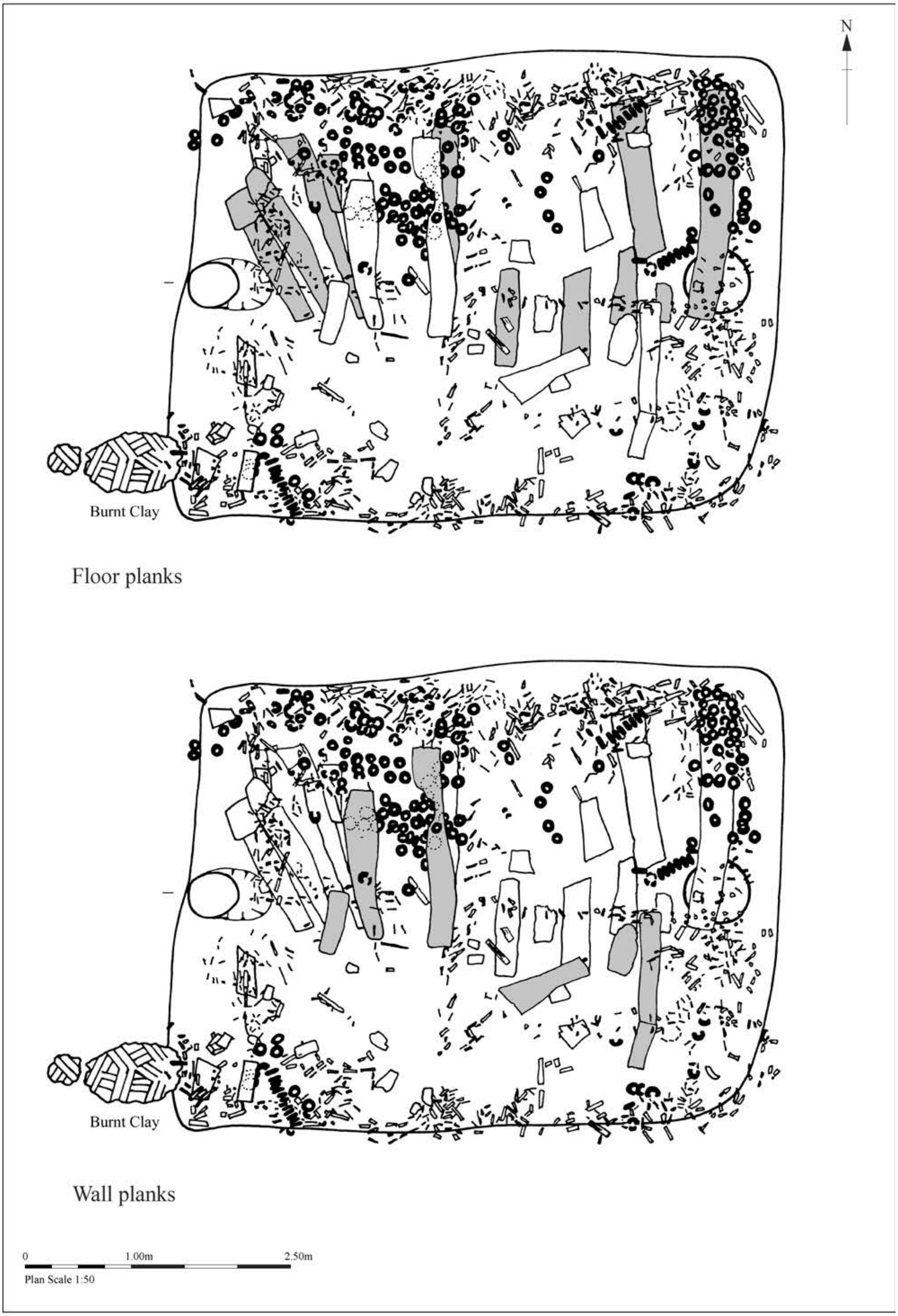

Figure 7.7 Plan of the charred planks across the base of SFB 15 at West Stow identified by Stanley West as (above) collapsed floor planks and (below) collapsed wall planks (after West 1985, fig. 71)

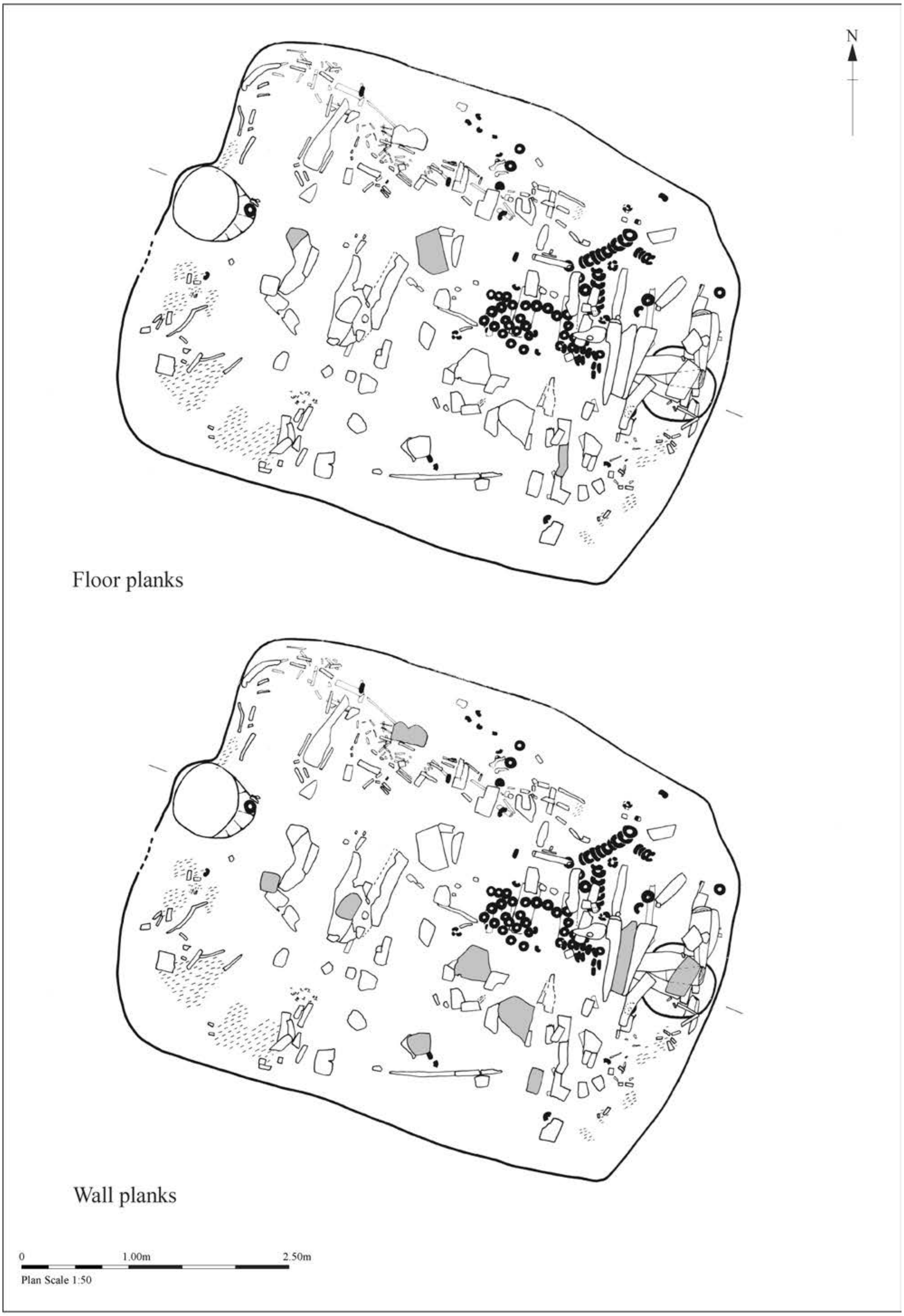

Figure 7.8 Plan of the charred planks across the base of SFB 3 at West Stow identified by Stanley West as (above) collapsed floor planks and (below) collapsed wall planks (West 1985, fig. 35)

3 and 15 collapsed outwards away from both the sunken features like the gable-end walls of the Farmer's House. This, again, is likely to have resulted in only superficial charring, based on comparison with the Farmer's House.

Five out of the six possible wall boards in SFB 15 reached to or beyond the central ridge line, marked by the position of the two gable post-holes. The furthest tip/edge of the charred boards that presumably came from the N wall (based on West's interpretation) was up to *c*.2.60m from the N (upper) edge of the sunken feature; this would mean the height of the wall was at least *c*.2.60m high (min.) assuming the wall line was along the upper excavated edge of the sunken feature. However, West argued that the slope of each sunken feature needed to be projected further outwards by *c*.0.40m to 0.60m to the level of the original ground surface (West 1985, 115). In the case of SFB 15, this would increase the size of the sunken feature to *c*.6.20 x 5.00m in area x 0.69m in depth. Therefore, the furthest tip of the longest wall board would have been *c*.3.00m from the original projected edge of the sunken feature.

Moreover, West suggested (1985, 115) that the size of the actual building was considerably larger than the sunken feature. If the wall line was a further *c*.0.50m from the upper edge of the sunken feature as West suggested, the original building would be *c*.7.20 x 6.00m in overall size. Using this calculation, the wall boards would had fallen even further. Assuming the boards simply collapsed inwards and down, the S (upper) end of the longest wall board would have been up to *c*.3.50m from the original wall-line.

It seems unlikely, but not impossible, that the side walls of SFB 15 were 3.50m high, or even 2.60m. In comparison, the walls along the N and S (long) sides of the Farmer's House, and the other reconstructions of SFBs with suspended floors, are *c*.2.00m in height. Assuming West's interpretation is correct, i.e. that SFBs had vertical walls on the ground surface beyond the edge of the sunken feature, this raises a concern about his interpretation of the upper layer of charred planks as the remains of wall boards which simply collapsed inwards, or about the position of the wall line in relation to the edge of the pit.

West (1985, 16 and 23) was quite clear about the stratigraphic sequence in both SFBs 3 and 15. However, it is possible that the upper layer of charred planks is, like the lower layer, also the remains of the suspended floor. The overlapping planks might be the result of staggered and variable collapse, with some planks dropping straight down and others collapsing at a later stage during the fire, at an angle and on top of earlier collapsed floor planks. This appears to be what happened in the Farmer's House. Pot-sherds from several vessels, which were originally on a shelf above head height, were shown to be at a stratigraphically lower level to some of the collapsed floor planks and embedded within the occupation layer below the suspended floor. Presumably the pot-sherds fell between gaps that opened up between burning suspended floor boards, and as a result of differential collapse. In SFBs 3 and 15, the loomweights could have been sandwiched between different charred floor planks, rather than between floor and wall planks, based on the comparative evidence from the Farmer's House, which showed that the floor planks did not all collapse down together. It seems probable that the wall boards from SFBs 3 and 15 were completely destroyed.

The cellar pit

In both SFBs 3 and 15, the fill above the charred remains consisted of a brown sand fill *c*.0.15–0.20m deep (West 1985, fig. 71). The homogeneous nature of these fills suggested both sunken features were deliberately infilled. Like the other SFBs at West Stow, there was also no evidence of side collapse in either of their sunken features during use or of subsequent erosion after the fire. This is surprising given the amount of general disturbance that might have been expected when the structure collapsed (and also afterwards), and on comparison to the Farmer's House. Instead, the evidence from SFBs 3 and 15 suggested they had been filled in rapidly after their destruction. The fills of both sunken features, above the burnt structural remains, contained over 100 sherds of Anglo-Saxon pottery, as well as over 100 fragments of animal bone and a variety of small finds (Chapter 1). None of these objects showed any evidence of burning. Although they are relatively small compared to many other SFBs, the presence of material culture assemblages also argues for deliberate deposition of material from elsewhere, after the event, and against natural infilling.

In comparison, the cellar pit of the Farmer's House had suffered from extensive side collapse during the fire and further collapse after the fire. As a result of the fire, the size was considerably larger than the lined cellar and the shape of the pit was irregular. However, both the sunken features of SFBs 3 and 15 were considerably shallower than the Farmer's House cellar pit and they had gradually sloping (rather than vertical) sides cut into the natural. Moreover, the cellar in the Farmer's House was erected as a free-standing box in a much larger pit and the area behind the lining was subsequently infilled with re-deposited, and less consolidated, sand. The effect of this method of construction, and the current ground conditions (which had been re-instated after the original excavation in 1972), therefore, would have been considerably different to a pit cut into undisturbed natural.

In the case of the Farmer's House, the stratigraphic sequence is interesting because the floor planks collapsed onto the base of the cellar before the cellar lining gave way (see below). A number of floor planks were sealed below the upper part of the cellar lining (although the lowest part of the lining was *in situ*). Without knowing the structural form of the original building, it seems quite possible that this evidence could be mis-interpreted, i.e. that the floor planks were originally laid on the base of the pit.

Like the evidence from the Farmer's House, there was also evidence for charred *in situ* planks around the lower part of the burned cellars from late Saxon Ipswich. However, in contrast, there was no evidence within any of these late Saxon cellared buildings to suggest that the plank lining or suspended floor had collapsed onto the cellar base. There was also no evidence to suggest the material behind the lining had collapsed inwards; the charred structural remains were sealed below domestic rubbish that had been subsequently deposited into the pits. Presumably, the lining had been securely held in place behind the closely spaced posts. Moreover, the material behind the lining was possibly more stable as the cellar pits were generally cut afresh into the fluvial sands and gravels. The survival of charred structural evidence in the cellars in Ipswich, and also within the base of SFBs 3 and 15, indicates the remains in all of them were covered over relatively quickly, and protected from weathering and degradation; this is supported by the lack of evidence for gradual accumulation within their fills.

The position of the trapdoor remains on the base of the cellar pit in the Farmer's House, directly below its location within the original building, suggests that it was still in place when the fire took hold and had not been removed by arsonists. This indicates that the fire started above the planked floor or, at least, that it was not deliberately started in the cellar, unless the trapdoor was replaced after the fire had been started which seems unlikely (whether or not it was the intention to burn down the building). Instead, the evidence suggests that the trapdoor simply dropped straight down into the pit, presumably as the supporting joists gave way. This seems most likely as the trapdoor was also heavy and difficult to remove without tools to lever it out.

Fixtures and fittings

Different fixtures and fittings within the building were spread across the remains — outside the wall-line of the building, on the ground surface within the interior and at different stratigraphic levels within the cellar pit.

The metal fittings from the chest, originally on the suspended floor and against the wall on the E side of the door, were spread across an area *c*.2.00m N–S (horizontally), and at different levels within the SE part of the cellar pit. One of the hinges was on the base of the cellar *c*.2.90m N of the original wall-line. All the chest fittings were within the cellar pit (although at various levels) even though the chest had not been directly above the cellar pit and was located on that part of the floor beyond the cellar. Moreover, the fittings were generally above the collapsed cellar lining, within or on the surface of the material that was originally behind the lining.

The fire-box, in the central (N) part of the building, was supported on the suspended floor until a very late stage in the fire and after the entire superstructure had been almost entirely destroyed (Plate 3.2). The remains were also sealed below the collapsed lining on the base of the cellar. The spearhead, originally fixed to the upper tie beam (*c*.2.75m above the suspended floor), was lying directly on top of a collapsed floor plank on the base of the cellar and sealed below the collapsed cellar lining.

The dispersal of pot-sherds from the vessels on the shelf, *c*.2.00m above the floor in the SW corner of the building is also revealing. Sherds from the same, originally complete, vessel (V1) were dispersed 3.50m (horizontally). 63 sherds from this vessel were recovered on the ground surface. Although the sherds were mainly inside the wall-line, some were on the wall-line (where the floor joist had been completely destroyed) and a few were outside it. 88 sherds from the same vessel were found at various levels within the cellar pit, at the level of the collapsed floor planks on the base of the cellar and above the collapsed cellar lining, with several sherds wedged behind the SW corner-post.

Evidence of the suspended floor

Fragments of nine different floor planks (max.), in varying lengths, were preserved on the base of the Farmer's House cellar, which is approximately 3% of the original suspended floor. Five planks were at least 0.50m long and two were over 1.00m. In contrast to many of the other surviving timbers that were only partially charred, all the surviving floor plank fragments were completely charred. The burning floor planks presumably collapsed down and then continued to smoulder on the base of the pit, where the oxygen level would have been limited after the inward collapse of the cellar lining; the spoil from behind the cellar lining presumably smothered these remains. Therefore, it is very likely that these would survive in the archaeological record, a) because they were completely charred unlike many of the surface remains that were only superficially charred and b) because of their protected location on the base of the cellar pit, which is less likely to be disturbed in comparison to the remains on the ground surface that normally, due to later truncation, have been destroyed.

The fact that any suspended floor planks were preserved on the base of the pit is significant, and there are a number of similarities between the Farmer's House remains and the evidence from SFBs 3 and 15, in the N–S alignment and relatively orderly arrangement of the carbonised planks across the base of the sunken features (West 1985, figs. 35 and 71; Figs 1.4–1.5 and 3.9). In the Farmer's House pit, however, the surviving floor planks were located close to the sides and corners of the pit, preserved below, and only as a result of the collapse of, the cellar lining. The great intensity of the second phase of the Farmer's House fire, when the fire burned fiercely in the oxygen-depleted environment within the cellar pit, completely destroyed those timbers of the floor and cellar lining across the centre of the pit.

Eleven plank fragments were identified by West as floor planks in SFB 15 (West 1985, fig. 71). Six of these were over 1.00m long (and nine over 0.50m), measuring up to *c*.2.25m long. A further six charred planks across the base of the sunken feature were identified as wall planks (see above). The widest plank on the base measured 0.30m wide and this is taken to calculate the width for all the planks (clearly, there was probably variation in width of timber). This gives an area of surviving floor measuring 3.99m^2 in size.

Based on the size of the sunken feature as excavated (i.e. the surface area), 14.9% of the suspended floor in SFB 15 was preserved in the base or 9.2% if the wall line is set 0.50m from the projected or reconstructed edge of the sunken feature (based on West 1985, 115). However, using all the charred planks on the base (i.e. including those interpreted as wall boards by West, which is an additional 2.03m^2 of charred planking; see above), the figure rises to 22.5% based on the excavated area of the sunken feature and 13.9% if the wall line is projected beyond the edge of the reconstructed sunken feature. In comparison, only 8.25% of the floor was preserved in the Farmer's House, based on the size of the cellar pit alone or 3.05% of the original floor that extended beyond the cellar.

Accumulation deposits on the base of the cellar pit

In the Farmer's House remains, the charred floor planks were lying on top of a construction and occupation layer across the base of the cellar and *c*.0.20m above the cut for the pit. In comparison, the planks in both SFBs 3 and 15 were directly on the base or cut of these sunken features. There was no evidence of a disturbed construction deposit on the base of either SFB 3 or 15, and there was also no evidence of material (either soil, organic matter or objects) that had filtered down the gaps between suspended floor planks and accumulated on the base of their sunken features. Moreover, there was no apparent evidence of

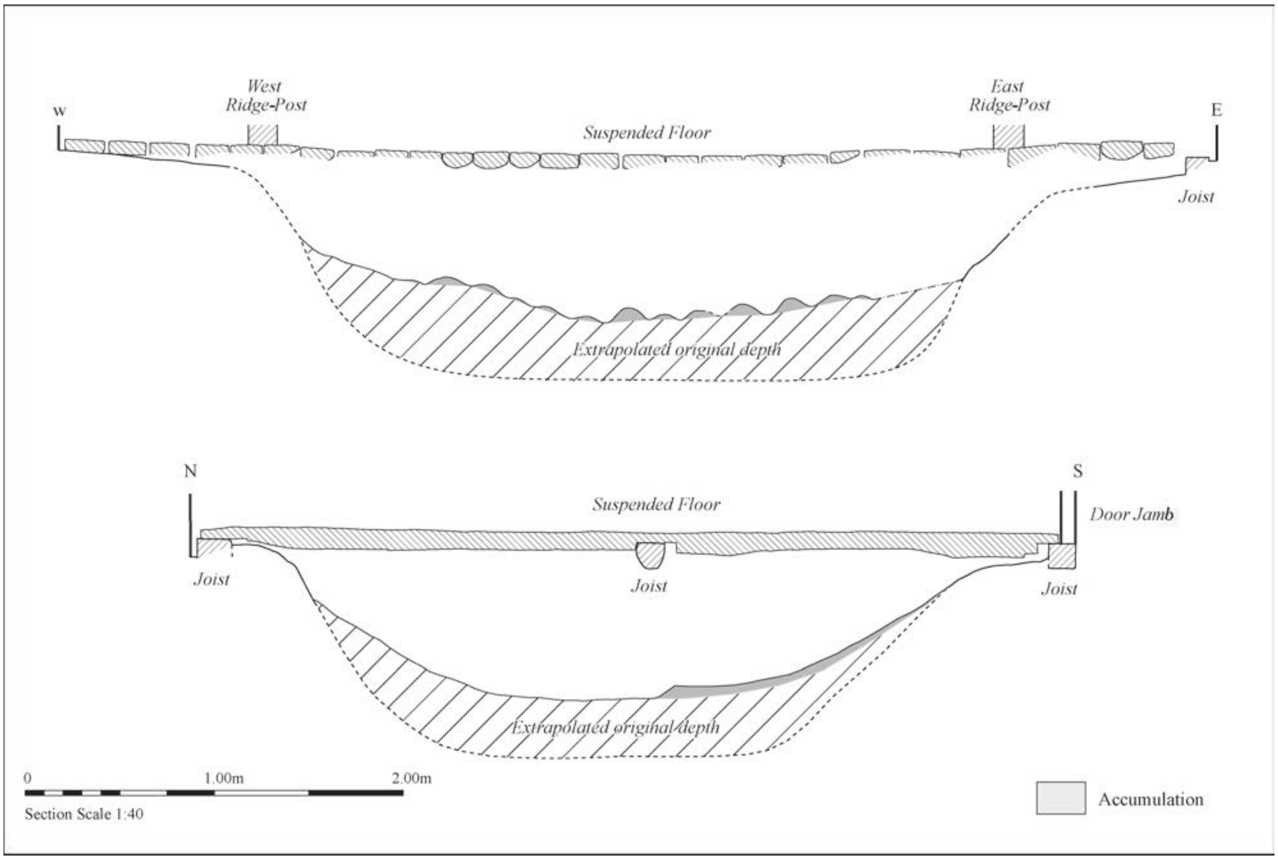

Figure 7.9 Profiles to show the ridges of accumulation on the base of the sunken feature, below the suspended floor, of the Weaving House (recorded in October 2004). The original depth of the cut is an approximation (and, therefore, the amount of accumulation below the suspended floor is also an estimate), based on the estimated reconstructed depth of SFB 20 which was 1.10m (West 1985, 26)

burning to the base or sides, directly below the planks, in either of the sunken features.

The ridges of material on the base of the cellar and on the protected ground surface below the entrance, which had formed below the gaps between suspended floor planks within the Farmer's House, had been flattened by the time of the excavation. The position of the ridges was, however, preserved as distinct V-shaped areas of uncharred timber on the inner side of the outer joist along the S side of the building and also on the lowest plank of the cellar lining below the doorway. It seems just possible, therefore, that they might be preserved in the archaeological record if the organic component of the timbers was replaced with soil. Otherwise, the surviving evidence would consist probably of a thin horizontal layer of material across the base of the pit, varying in thickness depending on the original height of the ridges and generally containing small objects.

The evidence of accumulation deposits within the Farmer's House is particularly interesting for the study of Anglo-Saxon SFBs, burnt or not. Prominent ridges of fine sand have also accumulated on the base of the other reconstructions with suspended floors at West Stow, none of which have any floor coverings. These provide some important pointers about the type of archaeological evidence that might occur below suspended floors. The difference between the top of the ridges and base of the troughs (that are directly below the floor planks) in the Weaving House (recorded in October 2004) was *c*.0.10m (Fig. 7.9, Plates 7.6 and 7.7); the ridges were even more prominent in the Living House, although they have not been accurately recorded (Plate 7.8).[viii] The overall depth of the accumulation deposits in these buildings above the original cut or construction layer of the sunken feature, however, is unknown and has not been the subject of detailed investigation. Already, the process is apparent on the base of the cellar pit in the replacement Farmer's House, which has linear ridges of fine grey sand *c*.0.05m high across the base below the gaps between suspended floor planks that are *c*.10–20mm wide.

Unsurprisingly, the location and extent of the ridges in the reconstructions reflects the size of the gaps between floor planks, with prominent ridges directly below the widest gaps. Within both the Living and Weaving Houses, the gaps between floor planks are slightly more irregular, up to 35mm wide in the former and 40mm in the latter but generally less than this. The gaps were considerably smaller, however, when the floors were originally laid, and this is the result of subsequent shrinkage of the green oak planks. Like the Farmer's House, the extent of the accumulation was also considerably greater below the doorways in both the Weaving and Living Houses.

In comparison to the accumulation of material inside, prominent erosion hollows have developed outside the doorways of all the buildings from visitors which, from time to time, have to be infilled by staff (Fig. 7.10 and Plate 7.9). There was no such evidence from the original excavations, around any of the sunken features, although the volume of foot traffic is likely to be considerably higher within the reconstructed site, which has *c*.20,000

Plate 7.6 The ridges of material (at least four visible within the photograph) that have formed below the suspended floor, across the base of the sunken feature, within the Weaving House (taken in October 2004). The doorway is in the top-left corner of the image

Plate 7.7 The ridges of material that have formed below the suspended floor, across the base of the sunken feature, within the Weaving House (taken in October 2004). The central E–W joist is on the left side of the picture, supporting the suspended floor planks. As well as fine sand, the material includes hazel batons, bark, straw, paper and pencils

visitors each year, than in the original Anglo-Saxon settlement.

A large quantity of objects has accumulated on the base of these sunken features by falling between the gaps; narrow or thin objects, especially pencils dropped by school children, are particularly common, demonstrated by the large quantity of pencil lead recovered from the base of the cellar pit in the Farmer's House. Similarly, a small test pit below the suspended floor of the Living House, dug in April 2008 to examine the condition of the E ridge-post, produced pencils as well as a variety of other objects that must have slipped between the floor planks. The material below the suspended floor in the Weaving House includes hazel batons, thatching sedge, paper and bark from the underside of the floor planks, lying parallel to and directly below the suspended planks; the floor planks are simple box-halved planks, left in the round and with the bark still on. Although the types of activities taking place are very different, and it is impossible to compare the material lost by Anglo-Saxon occupants with material lost by re-enactment groups, visitors and tourists, the evidence from the Farmer's House and other reconstructions is important because it does reveal how easily, and how much, material can fall through the narrow gaps between boards.

In comparison to the modern evidence, the lower fill of the SFBs excavated at West Stow was 'noticeably similar in all of those found and consisted of a fine-grained, compact grey-brown material with little evidence of stratigraphy. Flecks of charcoal were common, thin lenses of ash were occasionally observed, and trickles of sand were occasionally observed at the edges, apparently resulting from the drying out and dusting from the surface of the walls' (West 1985, 117). West interpreted this fill as a primary occupation deposit that had formed as a result of gradual accumulation below a suspended floor during the original use of the building (West 1985, 120), although it has also been suggested that this material could have been deposited on or after disuse, and once the suspended floor had been removed (Tipper 2004). There was no evidence of any ridges in the excavated sunken features at West Stow. Moreover, no evidence of ridges, or subtle linear

Plate 7.8 The ridges of material that have formed below the suspended floor, across the base of the sunken feature, within the Living House (taken in April 2008). The ridges are particularly clear on the ground surface inside the doorway. The sunken feature contains a considerable amount of straw, much of which has fallen between the gaps during thatching repairs earlier in the year (although a plastic cover was placed over the floor to prevent this)

deposits that might be the remains of ridges, have been yet identified on the base of any SFBs investigated in this country, although it is just possible that any subtle evidence could been overlooked in fills that are often rapidly excavated to recover the finds and plan of the sunken feature.

Evidence of joints and pegs

Only several joints from structural timbers were identifiable. A mortise for a door-post was preserved as a charred and enlarged hollow in the partially charred outer joist; the other had been entirely destroyed. The remains of both the upper tenon-end of the W ridge-post and NE corner-post were preserved because these posts had fallen

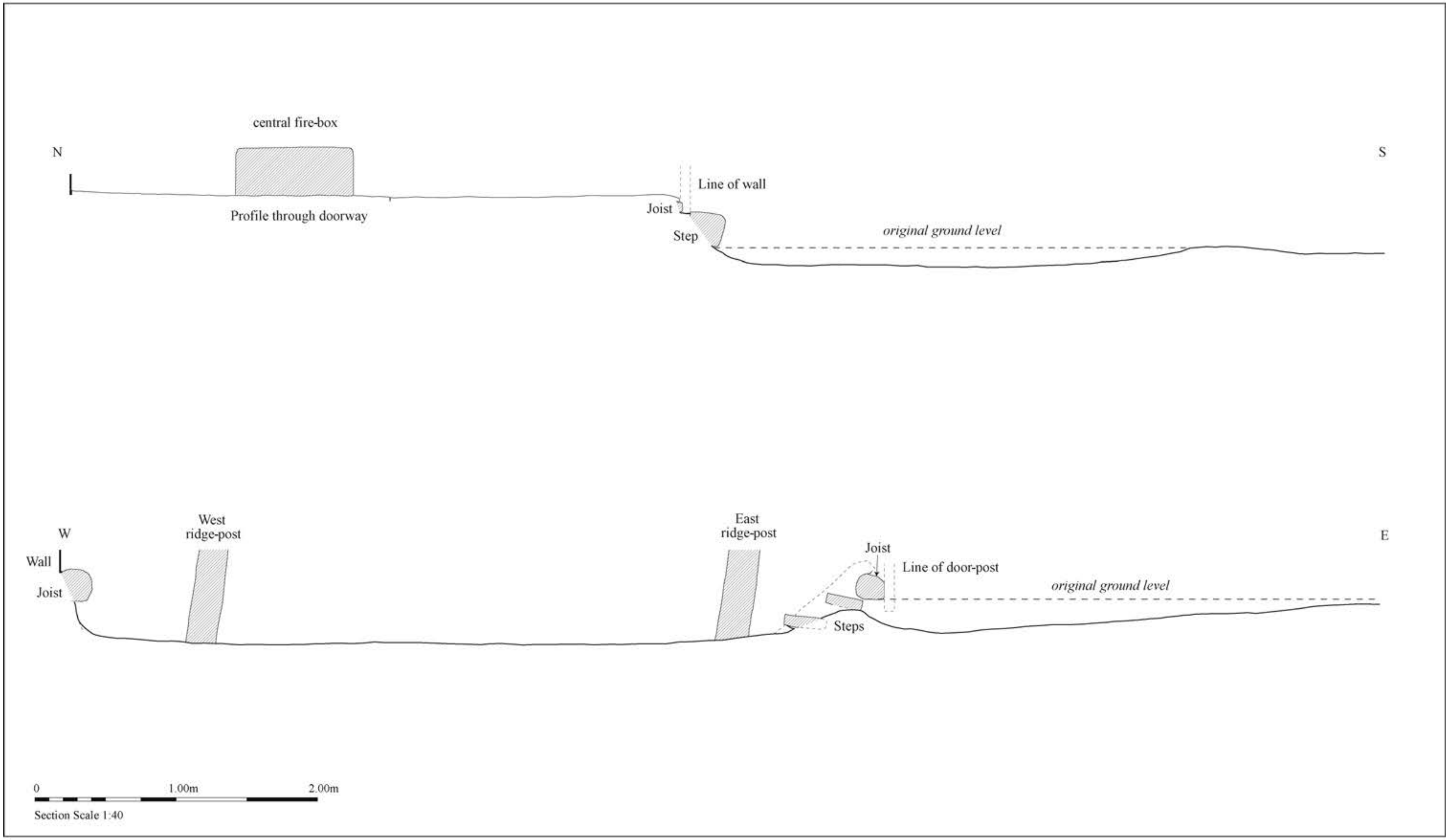

Figure 7.10 Profiles showing entrance hollows, caused by trampling and erosion, outside the Living House (above) and Sunken House (below) (recorded in November 2005). In both, the hollows have been periodically infilled by staff. In the Living House the erosion hollow has formed outside the doorway and the doorstep has been undercut. The erosion hollow is even more pronounced directly below the window, to the W of the door, also on the S side of the building. In the case of the Sunken House, the erosion hollow that has formed outside the doorway, on the E side of the building, is almost as deep as the sunken floor inside the building. The joist and door-post has been undercut entirely in the area of the doorway while on the opposite (W) side it has been also significantly undercut

Plate 7.9 The erosion hollow that formed in front of the Living House door, before the hollows were infilled (in November 2005). There is a prominent hollow of bare sand in front of the entrance and below the window. Notice the extent to which the outer floor joist and wall boards, directly below the window, and also the lowest step, have been undercut through wear and erosion

outwards and away from the fire. In both cases, they were only partially charred and it is unlikely they would have been preserved in the archaeological record.

The joints were the weak points of the frame and subject to preferential burning and destruction. This is because the surface area of timbers was increased and, therefore, ventilation was higher at the joints. Consequently the joints were subject to preferential burning and destruction. It is, therefore, unsurprising that evidence of jointing was not preserved in the evidence from either SFBs 3 or 15.

A number of peg-holes, containing charred pegs, were preserved on partially charred wall boards that fell outwards and away from the fire. The charred pegs and peg-holes were also preserved in the surviving outer floor joists (for the wall boards on the outer side and for the floor planks on the top). The only (charred) pegged joints identified within the cellar pit, however, were from the step-ladder.

Posts and post-holes

The evidence from the Farmer's House demonstrates that the lower parts of posts are unlikely to be charred in a building fire. The base of all six posts within their post-holes, and also the lower parts of the two ridge-posts protected behind the cellar lining (and by the subsequent collapse from behind the lining), were completely uncharred. This was true in every example within the base of the cellar, where the fire was most intense, and also on the ground surface outside the wall-line where a number of stakes had burnt down to ground level. The lower parts of the posts (above the post-holes) within the cellar were also uncharred because they had been protected by the accumulation of material on the base around them.

The evidence from the Farmer's House is similar to that from the burnt remains of a ground level reconstruction at Lejre (House 1), based on the burnt remains of Early Iron Age long-houses in northern Jutland, with byre at one end and living quarters at the other (Rasmussen 2007). The building, which was in a poor state of repair, was intentionally destroyed by fire in 1967, as part of a controlled experiment. The remains of the building were then covered with 0.10m of earth in 1968 and subsequently partially excavated in 1992–3. These investigations also showed that both the roof-bearing posts and also the stall partitions were completely uncharred below ground (Bjarke Christensen *et al.* 2007, 87 and figs. 47–52[ix]). It is, therefore, unsurprising that burnt earth-fast post-hole buildings are unrecognisable by conventional excavation because they leave little visible evidence once the original ground surface has been removed.

Both these examples contradict Barker's suggestion that a post would be turned to charcoal below ground, in the post-holes, where there is less air (Barker 1993, 22–3). This has been suggested on a number of excavated buildings. In the case of the large Iron Age roundhouse excavated at Longbridge Deverill, it was suggested that the main structural timbers had 'burned right down to their post-holes, and the resulting scorched post-sockets and fillings of fine burnt earth and charcoal were very noticeable' (Chadwick Hawkes 1994, 57).

The evidence from both West Stow and Lejre, however, supports Atkinson's assertion that a post below-ground will not normally burn 'if the below-ground timber is sound and solid' (Atkinson 1985, 47). Atkinson went on to suggest that a post may burn below ground 'if the buried timber has been degraded by fungal and bacterial attack' (1985, 47). However, the base of the two posts set midway along the long sides of the cellar possessed evidence of substantial decay with only a small central part of each post surviving. The charred base of the central post along the S side survived to a height of *c*.0.25m above the base of the lining. Like the other posts, the base of the post in the post-hole remained completely uncharred. The lower part of the post also survived uncharred, *c*.0.10m high above the post-hole, because of the accumulation of material within the cellar pit. This post was in an advanced state of decay below ground and was just 0.05m wide.[x]

Of the roof-bearing posts, only the E ridge-post was investigated in the summer of 2005 (further posts were, however, subsequently investigated; see below). This post, and also the central posts along the long sides, give an indication of the condition of the posts at the time of the fire and of their decay since erection, although it must be remembered there was a four-month interval between the fire and investigation during which time the rate of decay might have increased significantly. The base of the E ridge-post was exposed in section during excavation (only the N face of the post was exposed) and decay was shown to be quite limited[xi]. The outer edge of the post (<15mm) had rotted, leaving a fine band of dark material marking the original post, defined against the clean yellow sand backfilled around the post. Fine material had filtered down into the void that developed around the outer part of the post, rather like the sequence of post decay described in detail at Butser, resulting in a combination of soil and rotting wood fragments around the timber (Reynolds 1994). The outer part of the surviving post was also slightly soft or spongy as a result of rot. In particular, decay from fungal attack occurred on one corner of the post, probably along a fissure or crack in the timber. Nevertheless, the post was structurally sound due to the large size of the original, heartwood post (0.18m thick). Moreover, there was no sign of any movement in the building, to suggest any instability caused by the decay of any posts.

Although this information does not directly relate to the fire, it contributes more generally to understanding the life history (the change and decay) of earth-fast timber buildings in similar geological environments, although the rate of decay depends on various factors, including the moisture content in the ground, the quality and the type of timber. Equal decay between posts should not be assumed; the strength of timbers will also be more or less susceptible to decay depending on the presence and number of fissures, splits and knots. The density of specific timber varies even within the same tree, and within different trees of the same species, and therefore, the degree of fungal attack will vary.

It is also possible that charcoal might be incorporated into a post-hole through the progressive decay of the buried part of the post and gradual replacement by material filtering in from above ground, in the same way as post ghosts or post-pipes are often preserved in the base of post-holes (Barker 1993, 22–3), or through the sudden and catastrophic collapse of material from above into the void or air-space created by the decay of the post below-ground (Atkinson 1985). In either case, this might be the only indication to suggest that a building had been destroyed by fire[xii]. As the surviving wood rots away from the top down, it seems likely that the void might be replaced with charred material filtering downwards from above. This was apparently the case in the burned buildings at Yeavering (Hope-Taylor 1977, 34–45). It should be borne in mind that charcoal might also enter a post-hole as a result of the deliberate charring before insertion of the buried part of the post, to prolong the life of the post; the outer char layer presumably insulates the unburned timber although no research has been undertaken to establish whether or not this is the case. This is a practice that was undertaken until recently in some parts of the country, and it might have earlier origins (Atkinson 1985, 47). The posts within an Iron Age roundhouse construct (the Pimperne House) at Butser, set in post-holes cut into chalk, were shown to have decayed rapidly leaving a void for the post-pipe and it is also possible that charred material (and other objects) might become incorporated within the post-hole during the use of, and from activities within, the building (Reynolds 1994, 23). Therefore, it might be difficult, if impossible, to determine which of these processes was responsible for the evidence.

In addition to the E ridge-post, the SW corner-post was carefully excavated and recorded in May 2006 and the W ridge-post was investigated in May 2007, immediately before the rebuild, to assess the rot to the lower part of these posts, which had been left *in situ*[xiii]. The SW corner-post had a similar, perhaps slightly more advanced, level of decay to the E ridge-post (Plate 7.10). This post showed a decay-line occurring level with the top of the accumulation deposit, with *c*.10–20mm of rot to all sides of the post. There was, however, no appreciable difference in decay between the lower part of the post, set in the post-hole, and the part immediately above, which was protected from the fire by the accumulation layer.

In contrast to the SW corner-post, the lower part of the W ridge-post showed evidence of considerable rot (Plate 7.11). In cross section, the surviving post had an irregular star shape due to differential decay; the corners of the post survived preferentially while the flat surfaces of each side had decayed more quickly, presumably due to natural defects such as splits and fissures within the timber. The original extent of the post was clearly defined, with the outer, decayed part of the post forming a post ghost of dark brown humic material within the post-hole.

It is probable that the extensive decay of the W ridge-post has taken place after the destruction of the superstructure, rather than during the life of the building, given the considerable difference between the two ridge-posts and the two-year timelag between the investigation of the two posts. This is presumably as a result of the increased (and more variable) moisture content of the surrounding soil without the protection of the building, and thus greater fungal attack, during the interval between the fire and investigation, and during the interval between the extraction of the different posts. The light sandy soil conditions at West Stow are favourable to water movement and, therefore, high bacterial decay of timber and other organic remains. This does not entirely explain the considerable difference in preservation between the SW corner-post and the W ridge-post. However, as previously stated, the degree of fungal attack will vary and it should not necessarily be assumed there will be equal decay between posts.

A similar observation was made at Lejre (Bjarke Christensen *et al*. 2007, 87–9 and figs. 47–9). The post bases, which also survived the fire uncharred, were in an advanced state of decay in 1993 and it was concluded that ‘House 1 decayed during the 25 years that elapsed between burning and excavation’ (Bjarke Christensen *et al*. 2007, 89). It is, however, unclear how decayed the posts

Plate 7.10 The base of the SW corner-post, investigated in May 2006. The line of charring stops at the level of the accumulation on the base of the cellar. The post is entirely unburnt below this level. The level of decay to the lower part of the post is also clear

Plate 7.11 The base of the W ridge-post, investigated in May 2007. Notice, again, the line of charring also stops at the level of accumulation on the base of the cellar. The post is entirely unburnt below this level. There is considerable decay to the lower part of this post in comparison to both the E ridge- and SW corner-posts

were at the time of the building's destruction. The building at Lejre was structurally unstable and had a considerable lean when it was destroyed, which is the reason why it was selected for the experiment. This suggests the post bases were already rotten when the building was torched.

In the case of the Farmer's House, without disturbance, the uncharred posts within the post-holes would have completely decayed, leaving only a short length of carbonised timber lying vertically above and in line with the post-holes. Moreover, assuming the top of the *in situ* charred posts were sealed by side collapse and or backfill, they should be visible from a high level within the fill of the pit. It is also possible that the upper charred part of the post would gradually shift down with the decay of the lower part of the post, combined with other (burnt) material filtering down to fill the void of the post ghost. The remains of *in situ* charred posts, with the charred remains of plank lining wedged behind, were defined within several late Saxon cellared buildings in Ipswich (T. Loader pers. comm.). In these cases, the post surfaces survived as thin veneers of charred material on the three outer facing sides — the interior of each post, and also the outer side (against the lining) had not burnt through, like the timbers at West Stow. This uncharred timber had rotted away to be replaced by soil that subsequently formed post ghosts outlined by charcoal. Like the evidence from the Farmer's House (and also Lejre), the post bases, set with their post-holes, were also entirely uncharred and the decayed timbers had been replaced by soil, which presumably filtered down from above (T. Loader pers. comm.; Plate 7.4). It was a similar case with Structure N4 in Dover (Philp 2003). Only the inner face of the surviving wall planks was carbonised, and the surviving traces were only 0.01–0.02m thick; the remaining parts of the planks, which were uncharred, had rotted away (Philp 2003, 15). Again, only the outer skin of the ridge-post survived, because it had been charred, and the core had rotted away. That part of the post within the post-hole had not been charred (Philp 2003, 20).

There was no evidence of charred posts or stakes within the base of any post- or stake-holes associated with SFBs 3 or 15. One of the post-holes in SFB 15 was sealed by a charred floor plank. This was also the case in SFB 3; the E ridge post-hole was sealed by various fragments of charred timber. Presumably, the posts burned through and snapped off at or just above ground level before the floor planks collapsed down across the post-hole. The base of the posts, within the post-holes, would thus have decayed like any other wooden post. The void might have been filled with charred material that filtered down from above, but there was apparently no evidence of a post ghost within any of the post-holes. In SFB 15, the material in both ridge post-holes was described as brown fill with sandy patches. In both, although most prominent in the W gable post-hole, there was a thin band of charcoal towards the top of the fill sloping down toward the centre, which has presumably accumulated in the top of the hollow after the post had decayed. There was also evidence of a second possible lens halfway up the post-hole. In the E post-hole this was interspersed with several thin lenses, described as grey silt, tipping down towards the centre of the post-hole, and also across the base. It seems likely that the upper parts of the posts were either completely destroyed by the fire or were only superficially charred, so that the surviving timber decayed subsequently through normal microbial action. To complicate the issue, some or all of the surviving timbers might have been salvaged and extracted from the remains.

VI. The archaeological context: the destruction of SFBs 3 and 15

with Karl Harrison

The evidence from both SFBs 3 and 15 suggests they were both lower intensity fires compared to the Farmer's House — perhaps because of the shallower depth of, combined with a lower fuel load within, their sunken features, or perhaps because they were constructed differently. In either case, this might imply that much of the superstructure from both SFBs 3 and 15 would have been only partially destroyed by fire.

The large quantity of unfired or lightly fired loomweights in both SFBs 3 and 15, for example, was high compared to the quantity of fired loomweights. 28,800g of clay loomweight material was examined from SFB 3 and only half (by weight) was recorded as being fired (*c*.13,300g)[xiv]. In SFB 15, the figure was much lower and only 11% (*c*.6000g out of 55,300g in total) was fired[xv]. The majority of material was unfired or lightly fired, although parts of many were lightly fired. This is similar to the evidence from the sunken-floored buildings at Upton and Old Swindon, which had also been destroyed by fire. At Upton there were several groups of loomweights (over 60 in total) and, again, many were not baked to any great extent (Jackson *et al*. 1969, 210). Over 150 loomweights were found in the sunken feature at Old Swindon, with the vast majority concentrated at the base of the side along the (S) W long side (the building was aligned N–S) with one long row of at least 20 loomwights. The majority were also unfired or lightly fired (B. Phillips pers. comm.). In Dover, most of the loomweights on the base of Structure N4 were only partially fired and those in the rows were only fired on their upper side (Keller 2003, 75). The evidence suggests that the fires in all these buildings were of lower intensity in comparison to the Farmer's House. Although there were no loomweights, with the exception of a small quantity of uncharred material preserved on the base of the cellar (sealed from the fire below accumulation during use), all the objects within the Farmer's House were heavily burnt.

The neat arrangement of charred planks across the base of both SFBs 3 and 15 also indicate far less intense and destructive burning events than the Farmer's House fire. Moreover, the surviving charred planks lying across the base of SFB 15 had a shallow 'U' shaped profile and West suggested the charring affected only the underside or lower surface of the planks (West 1985, 23; Fig. 7.11). It would appear that the upper surface and central part of each plank had been completely destroyed, presumably as a result of the subsequent decay of unburnt timber, leaving (intact) only the lower and side charred parts of the timbers, *c*.0.02m in thickness (max.). The profile of surviving carbonised planks, therefore, shows that the upper side was protected from the fire and had not been carbonised, similar to the posts and plank lining within the late Saxon cellars destroyed by fire in Ipswich.

The 'U' shaped profile of the planks indicates a low-intensity smoulder combustion, causing charring to the three unprotected sides of an otherwise cuboid plank, and there were no obvious directional indicators to suggest this char was caused by a distant, radiative source. This evidence, combined with the apparent availability of fuel from the superstructure, indicates an oxygen- controlled smoulder that has failed to develop sufficient energy to progress to open flaming combustion. This is most easily explained as burning within the void beneath the suspended floor.

The directionality of charring, to the underside of the planks lying horizontally across the base of the sunken feature, also demonstrates that these planks were not laid directly on the base, as suggested by Welch (1992, 25). The char pattern on the surviving planks in SFB 15 demonstrates they had collapsed from above, although they could feasibly be from side walls that collapsed inwards and downwards instead of a suspended floor. Had the planks been laid directly on the base, the undersides, sealed from oxygen, would have remained unburnt while the upper surfaces would have been charred.

If this interpretation is correct, i.e. that the fire began below the suspended floor, it suggests that SFB 15, at least, was probably destroyed accidentally, as a result of smouldering material below the floor, and not as the result of deliberate destruction. Based on the evidence, it seems likely that flammable material, such as dry straw that has filtered below floor-boards, may have caught alight and smouldered below the suspended floor rather like the reconstruction at Bishops Wood Centre in 2009, where the fire developed below the floorboards. Several aspects of this interpretation, however, are still problematical and not adequately answered. This does not, for example, explain the total absence of any accumulation deposits across the base of both SFBs 3 and 15, compared to all the reconstructions with suspended floors at West Stow which show evidence for substantial accumulation deposits.

VII. Conclusions: the Farmer's House and the archaeological implications

On the basis of the close observations of the physical evidence discussed in Chapter 3, supplemented by the information provided by the images taken during the fire, and combined with the detailed forensic-style investigation, the following possible sequence of destruction can be suggested:

a. Rapid destruction of roof
b. Collapse of frame, with the exception of the posts, including collapse of (some of the) wall boards and some of the suspended floor
c. Collapse of the suspended floor and collapse of the posts
d. Inward collapse of the cellar lining, and the material behind and also on the surface around it
e. Continued burning in, and on the surface around, the pit
f. Subsequent decay of site through various natural processes

The severity of burning to the Farmer's House appeared to offer little potential, initially, for understanding the origin, development and resolution of the fire, except in the broad qualitative terms that are often applied to burnt structures in the archaeological record. However, a methodology making use of relevant fire investigative techniques and also models provided by

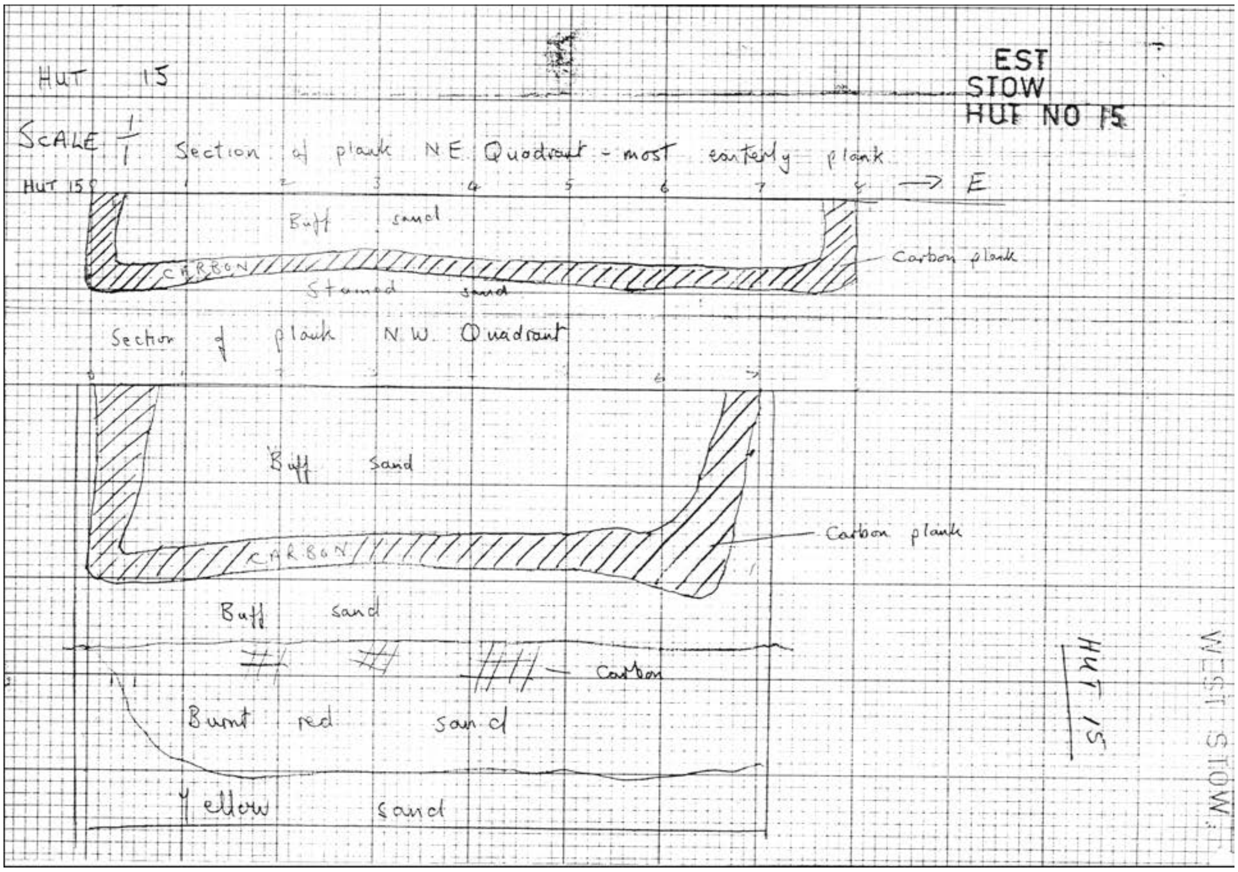

Figure 7.11 'U' shaped profile of a charred plank on the base of SFB 15. The charring affected only the underside or lower surface of the plank, which has consequently been preserved. Reproduced from the original archive drawing. *Courtesy of Stanley West, West Stow Anglo-Saxon Village Trust and St Edmundsbury Borough Council*

principles of fire engineering has allowed a range of detailed observations to be made in Chapter 6.

It has been suggested there was a rapid initial development within the building above the planked floor, which quickly spread to the thatched roof. The fire then burned through the fixings that secured the thatch, resulting in its deposition on the ground in lines following, and beyond, the N and S walls. In addition to this very rapid, vented fire, burning material fell through the gaps between the suspended floor planks initiating a second seat in the cellar void. The high concentrations of fuel in the plank-lined cellar, the limited ventilation and the depth below ground of the subsequent fire resulted in a more intense and destructive combustion compared with the initial fire.

While it is difficult to predict what the archaeological evidence might look like had the remains of the Farmer's House been left for 1,500 years, or even 50 years, the excavation of the burnt remains do present some markers. It is possible to put forward hypotheses about what the evidence might look like but further controlled experiment would be required to determine how the material actually decays in the long term to more fully understand the archaeological data; a decision was made early on following the fire to excavate and record the remains of this particular structure, rather than leaving them *in situ* to decay.

The results from the Farmer's House investigation are specific to this case study (Chapter 1). However, the work also provides insight about the nature of burnt structures more generally and highlights the range of potential techniques available in attempting to make informative comments regarding traces of structural fires preserved within the archaeological record. It has been suggested that the relative scarcity of burnt SFBs may be due to the fact that most buildings of this type were not constructed with hearths and, consequently, the risk of fire was considerably reduced. Moreover, buildings were often quite widely spaced apart on early Anglo-Saxon rural settlements, compared to later towns, so that the risk of a fire spreading between buildings was also considerably less. In particular, the problems of identifying surface buildings (as opposed to sunken-featured buildings) that have been destroyed by fire, and where the original ground surface has been truncated (in the case of the majority of rural sites), is especially problematical. It has been suggested that the number of burnt buildings is almost certainly under-represented in the archaeological record. The use of a range of scientific techniques, often (but not always) applied to modern excavations, has also been revealing and demonstrates the care that must been taken in the interpretation of archaeological evidence; it could easily have been possible to draw different conclusions without the background knowledge of the original building.

With the benefit of this detailed information, new insight can be gained and previous interpretations, based more often than not on reasoned logic, intuition and assumption, can be re-examined. Re-interpretation of old investigations is always constrained to varying degrees, by the quality of the original excavation and level of recording and availability (and also application) of scientific techniques. It is hoped that the evidence from the Farmer's House, and the methodology developed, can also be used to inform the investigation of future discoveries. The project has demonstrated the value that experimental archaeology, if undertaken with analytical rigour, can offer for furthering our understanding and interpretation of the archaeological record.

Endnotes

i This building, completed in 2001, was based on the ground plan of West Stow Hall 1 and employed a variety of different structural techniques.

ii However, like the Farmer's House, the fire took place during the night while the building, and site, was unoccupied. Unlike the Farmer's House, the Fire Service extinguished this fire and subsequently disturbed the remains in order to determine the cause of the fire, which severely limited the potential of the remains for any detailed archaeological investigation and comparison.

iii The surface area of the sunken feature measured *c*.5.95 x 4.40m which compares to the lined area which measured only 4.55 x 2.75m.

iv This is based on ridge-posts, corner-posts, door-posts, ridge beam, wall-plates, purlins, tie beams, wall boards and rafters.

v A representative sample of the charred timbers was buried in separate pits at West Stow in December 2005 (the remains of eight wall boards and two floor joists). The subsequent excavation of a pit at five-year intervals to re-examine these timbers and assess their further decay may lead to a closer understanding the taphonomy of the charred remains.

vi Measurements are based on the original field drawings.

vii In the calculations based on the plank measurements for both SFB 15 and the Farmer's House, no allowance has been made for shrinkage caused by charring.

viii In both, the floor planks are pegged down so the sunken features below the suspended floors are not routinely accessible for recording. The floor planks in the Living House were lifted in April 2008 when an attempt was made to record the ridges using a digital laser scanner; however, only a very small area across the pit was accessible to the scanner once the equipment had been set up within the building.

ix The soil at Lejre was characterised as 'light clayey soil mixed with a little sand, otherwise rich in organic material with a substantial humus content' while the subsoil was 'gravel and sand, in places with fist-sized stones, partly pure yellow clay' (Bjarke Christensen *et al*. 2007, 87). It was suggested that the humus-rich soil played a prominent role in the advanced state of decay of the posts.

x None of the posts had any form of preservative treatment, before insertion, to reduce the rate of fungal decay. However, the posts were placed on timber pads (i.e. flat pieces of oak inserted into the base of each post-hole), to give greater stability but also to help protect the end-grain of each post.

xi There appeared to be no appreciable difference in the decay of the post when it was subsequently extracted in October 2005.

xii The posts at Lejre had not been left long enough to inform this debate, i.e. the post bases had not yet sufficiently decayed to result in voids or downward movement of material when they were excavated in 1992–3.

xiii After the excavation was completed in August 2005, the empty pit was allowed to stand open, fenced off, for nearly two years until the rebuild, which began in June 2007.

xiv The ten complete loomweights in SFB 3 had a mean weight of 418g, ranging from 268g to 543g, which gives a total of *c*.69 weights.

xv There were an estimated 99 loomweights in SFB 15 based on the considerably greater mean weight of 557g for the 63 complete loomweights, ranging from 303g to 741g (with 39 between 500g and 700g).

Appendix 1: Method of thin section manufacture

The samples were impregnated by immersing them in a mixture of crystic polyester resin, acetone, and the catalyst methyl ethyl ketone peroxide (standard ratio of 1800ml resin: 200ml acetone: 30ml MEKP), and were placed under vacuum to ensure that no air was trapped while the resin infilled the pore space in the sediment. Three days after the initial impregnation, the resin bath was topped up with same crystic polyester resin mixture, with the addition of 10 drops of accelerator G. The blocks were then allowed to cure for several months, culminating in two days in an oven at 50°C to ensure complete hardening. Slices approximately 0.5cm thick were cut with a saw, lapped on a Brot thin sectioning machine, bonded to a glass slide with clear casting polyester resin, and precision lapped to a thickness of 30μm. The thin sections were hand-polished to ensure that they were of even thickness and fine finish, and finally cover-slipped.

Appendix 2: Methods of soil physical analysis

pH, magnetic susceptibility (MS), loss-on-ignition (LoI) and particle size analysis were all carried out in the Soils and Sediments Laboratory in the Department of Geography, University of Cambridge.

After air-drying, samples were sieved in order to remove constituents over 2mm in size. For pH determination, *c*. 10ml of sediment was placed in a 50ml plastic beaker and mixed with de-ionized water in order to form a slurry, the pH of which was measured in triplicate using a pHep 3 electronic pH meter. For magnetic susceptibility determination, 10cm^3 plastic pots were filled with the powdered sample and weighed in order to obtain the bulk density of the sample. Magnetic susceptibility measurements, calibrated against the earth's ambient magnetism, were taken in triplicate using a Bartington Instruments MS2 magnetic susceptibility meter with a low frequency sensor. The average of the three values was divided by the bulk density of the sample to give the mass specific susceptibility. Particle size analysis was carried out using a Malvern laser particle Mastersizer 2000 using a few drops of a sample suspension from a mix of 3g air-dried sample of <2mm soil, heated with 4.4% sodium pyrophosphate and centrifuged.

For loss-on-ignition (LoI), 10g the sample was placed into a crucible of a known weight and then fired at 100°C in order to evaporate away any moisture. The sample was then weighed again and after subtracting the second measurement from the first, the weight of only the sample was known. The crucibles were then fired in an oven at 480°C for 8 hours in order to burn away all the organic content. The crucible was then weighed again and the same method as above was applied in order to ascertain the new weight of the sample only. The LoI is presented as a percentage of loss between these two numbers.

The multi-element analysis (ICP-AES) was carried out by Als Chemex of Seville, Spain (www .alschemex . com). This technique measures the occurrence (by % or ppm) of a suite of 34 elements present in small bulk samples of soil/sediment, including heavy metals, calcium and phosphorus for example.

Appendix 3: The micromorphological descriptions

Sample 1

Main fabric 1: *Structure*: apedal, single grain; *Porosity*: 10–15% interconnected vughs between grains; *Mineral components*: 5% medium quartz, sub-rounded to sub-angular, 250–750μm; 20% fine quartz, sub-rounded to sub-angular, 100–250μm; 70% very fine quartz sand, sub-rounded to sub-angular, 50–100μm; 5% dusty clay, of grains, weak to moderate birefringence, pale grey to golden/reddish brown (CPL), pale greyish brown to black (PPL); *Organic components*: <20% very fine to fine to medium sand sized charcoal, 50–500μm; all fragments irregular and cell structure partially destroyed; 5–10% silt size charcoal punctuations, <50μm; most sand grains have a thin black 'sooty' coating of charcoal dust and/or amorphous organic matter present as a staining of the silty clay component; few (<5%) phytoliths; *Amorphous*: few (<5%) sesquioxide nodules, sub-rounded, <500μm; **Secondary fabric 2**: large intrusive, irregular zone of pale yellowish brown (PPL), very fine to fine quartz sand, 100–500μm, sub-rounded to sub-angular; 15–20% interconnected vughs. (Note: These two fabrics occur throughout the sample repertoire, with the former equating with the charcoal enriched burnt zone beneath a fallen timber, and the latter being the natural sand substrate.)

Sample 2

Upper 1.5cm: *Structure*: apedal, single grain; *Porosity*: 10–30% interconnected vughs between grains; *Mineral components*: as for fabric 1 in sample 1; pale yellowish brown (PPL), very fine to fine quartz sand with minor dusty clay coatings of grains, and minor (<10%) fine pellety amorphous/humified organic matter in between grains; **Lower 4.5cm**: similar to sandy fabric above, but contains some irregular zones of micro-aggregated, sesquioxide impregnated, silty clay fine fabric, <5% of total groundmass, dark reddish black (CPL), dark reddish/golden brown (PPL); 20–25% charcoal fragments, 50–500μm, partly humified and/or destroyed by soil faunal activity; *c*.10% plant tissue fragments, partly humified, partly excremental, partly replaced by amorphous sesquioxides, in all orientations.

Sample 3

Structure: apedal, single grain; *Porosity*: 10–30% interconnected vughs between grains; *Mineral components*: 5% medium quartz, sub-rounded to sub-angular, 250–750μm; 20% fine quartz, sub-rounded to sub-angular, 100–250μm; 60% very fine quartz sand, sub-rounded to sub-angular, 50–100μm; 5–10% dusty clay, of grains, weak to moderate birefringence; *c*.10% pellety humified organic matter between grains, <500μm, increasing slightly in upper 1.5cm of slide; upper 1–1.5cm with pale orangey brown (PPL) coloration of the fine quartz sand; remainder pale grey to golden/reddish brown to black (CPL), pale greyish brown to pale brown (PPL); *Organic component*: very few (<2%) fine charcoal punctuations, <500μm; **Lower 4.5cm**: similar micro-aggregated, sesquioxide impregnated, silty clay fine fabric, *c*.5–15% of total groundmass, dark reddish brown (PPL).

Sample 4

Upper 1cm: *Structure*: apedal, single grain; *Porosity*: 20–30% interconnected vughs between grains; *Mineral components*: 5% medium quartz, sub-rounded to sub-angular, 250–750μm; 20% fine quartz, sub-rounded to sub-angular, 100–250μm; 60% very fine quartz sand, sub-rounded to sub-angular, 50–100μm; 5% dusty clay, of grains, weak to moderate birefringence; *c*. 10% pellety humified organic matter between grains, <500μm; pale grey to golden/reddish brown to black (CPL), pale greyish brown to pale reddish brown (PPL); *Organic components*: two large fragments of charcoal, 5–30mm; frequent (10–20%) charcoal dust/punctuations in pore space, <50μm; **Middle 2.5cm**: *Structure*: apedal, single grain; occasional laminae seen in horizontal to 45 degree orientation of fine quartz and charcoal fragments; *Porosity*: 20–30% interconnected vughs between grains; *Mineral components*: 100% fine quartz sand, 100–250μm, sub-rounded; *Organic components*: 20–25% very fine to fine to medium sand sized charcoal, <500μm, all fragments irregular and cell structure partially destroyed; common (10%) silt size charcoal punctuations, <50μm; dark greyish brown (PPL); common charcoal dust often coating grains; **Lower 0.5cm**: *Structure*: apedal, single grain; *Porosity*: 30–40% interconnected vughs between grains; *Mineral components*: 95% fine quartz sand, 100–250μm, sub-rounded; <5% amorphous sesquioxide stained dusty clay and amorphous humic matter coatings of sand grains; pale yellowish brown (PPL/CPL); *Organic components*: <2% organic punctuations, <50μm.

Sample 5

Inner 1.5–2cm: *Structure*: apedal, single grain; *Porosity*: 10–20% interconnected vughs between grains; *Mineral components*: 95% fine quartz, sub-rounded to sub-angular, 100–250μm; 5% dusty clay coatings of grains, stained with amorphous sesquioxides, weak to moderate birefringence; pale grey to golden/reddish brown to black (CPL), pale greyish brown to pale reddish brown (PPL); *Organic components*: <5% plant tissue fragments, <500μm, partly replaced by amorphous sesquioxides; <5% very fine sand sized charcoal inclusions, <100μm, sub-rounded; undulating boundary over 0.5cm; **Middle 4.5–5cm**: *Structure*: apedal, single grain; *Porosity*: 30% interconnected vughs between grains; *Mineral components*: 95% fine quartz sand, 100–500μm, sub-rounded; <5% dusty clay coating of grains with amorphous sesquioxide impregnation; pale yellowish brown (PPL); *Organic components*: <10% pellety humified organic matter between grains; rare (<2%) charcoal punctuations; merging boundary over <1mm; **Outer 1cm**: as for the middle zone but slightly reddened.

Sample 6

Upper 1cm: *Structure*: apedal, single grain; *Porosity*: 20% interconnected vughs between grains; *Mineral components*: a few flint pebbles, <10% of groundmass, sub-rectangular to sub-rounded, 1–3cm; 90% fine quartz, sub-rounded to sub-angular, 100–250μm; 5–10% dusty clay coatings of grains, stained with amorphous sesquioxides, weak to moderate birefringence; pale brown (PPL), very dark brown to black (CPL), *Organic components*: 20–25% very fine to fine to medium sand sized charcoal, <500μm; <5% plant tissue fragments with horizontal orientation; <10% pellety fragments of humified organic matter between grains; rare (<1%) phytolith; *Amorphous*: few (<5%) sesquioxide nodules, sub-rounded, <500μm; **Middle 4cm**: as above, with <5% dusty clay coating grains and 5% pellety organic matter; pale yellowish brown to brown (PPL) with greater/lesser zones of sesquioxide impregnation; *Organic components*: <5% fine charcoal; **Lower 1.5cm**: *Structure*: apedal, single grain; *Porosity*: 30–40% interconnected vughs between grains; *Mineral components*: >93% fine quartz, sub-rounded to sub-angular, 100–250μm; <5% dusty clay coatings of grains with amorphous sesquioxide staining; <2% micro-sparite calcium carbonate in irregular zones/aggregates; pale yellowish brown (PPL); *Organic components*: few (<5%) fine charcoal, <100μm; *Amorphous*: few (<5%) sesquioxide nodules, sub-rounded, <500μm.

Sample 8

Upper 1.5–2cm: *Structure*: apedal, single grain; *Porosity*: 20–35% interconnected vughs between grains; *Mineral components*: >98% fine quartz, sub-rounded to sub-angular, 100–250μm; <2% dusty clay coatings of grains, stained with amorphous sesquioxides, weak birefringence; pale yellowish brown (PPL), dark brown to black (CPL), *Organic components*: <2% very fine charcoal, <100μm; merging boundary over <1mm; **Middle 1–1.5cm**: as for upper unit except weakly reddened, pale reddish brown (PPL), with up to 20% sesquioxide impregnated silty clay as irregular/small aggregates in pore space and 80% fine quartz sand; merging boundary over <1mm; **Lower 4cm**: *Structure*: lensed/weakly laminar zone; *Porosity*: 15–25% interconnected vughs; *Mineral components*: >98% fine quartz sand, sub-rounded, 100–500μm; dark greyish brown (PPL); rare zone of micro-sparite calcium carbonate, partly amorphous sesquioxide stained; *Organic components*: 10–20% pellety humified organic matter between grains, <250μm; 20% fine charcoal fragments, 50μm–1mm, exhibiting horizontal to 15 degree orientation; few (<5%) phytoliths; *Other inclusions*: very rare fragment of non-metallurgical slag or vitrified ash, sub-angular, 1–2cm; few (<5%) aggregates of calcitic wood ash, irregular, <500μm.

Sample 10

Upper 3cm: *Structure*: apedal, single grain; *Porosity*: 10–20% interconnected vughs between grains; *Mineral components*: 10% medium, 75% fine and 10% very fine quartz sand, sub-rounded to sub-angular, 100–750μm; very rare (<1%) chert, 500–750μm, sub-rounded; <5% dusty clay coatings of grains, stained with amorphous humic matter and sesquioxides, weak birefringence; pale yellowish brown (PPL), dark brown to black (CPL), *Organic components*: few (5%) plant tissue fragments; 30% fine charcoal, <250μm, fragmented, often oriented at 45 degrees; 10% pellety humified organic matter between grains; merging boundary over <1mm; *Amorphous*: few (<5%) sesquioxide nodules, sub-rounded, <500μm; **Lower 3cm**: *Structure*: apedal, single grain; *Porosity*: 10–20% interconnected vughs between grains; *Mineral components*: >95% fine quartz sand, 100–250μm, sub-rounded; <5% dusty clay with amorphous sesquioxide staining as coatings of grains; pale yellowish brown (PPL); *Amorphous*: few (<5%) sesquioxide nodules, sub-rounded, <500μm.

Sample 11

Upper 7cm: *Structure*: apedal, single grain; *Porosity*: 10–20% interconnected vughs between grains; *Mineral components*: 10% medium, 78% fine and 10% very fine quartz sand, sub-rounded to sub-angular, 100–750μm; with very few (<2%) sesquioxide impregnated silty clay discontinuous coatings of grains, weak birefringence; pale reddish brown to pale yellowish brown (PPL); *Organic components*: <5% fine charcoal, <100μm; few (<5%) plant tissue fragments; few (5%) oxidised plant tissue fragments; few pellety humified aggregates between grains, <500μm; **Lower 15.5cm**: *Structure*: apedal, single grain; *Porosity*: 30–40% interconnected vughs between grains; *Mineral components*: >98% fine quartz sand, sub-rounded to sub-angular, 100–250μm, with weak staining with amorphous sesquioxides; pale yellowish brown (CPL/PPL); interrupted by a large channel/root hole with infill composed of 3–4 alternating laminae of very fine charcoal fragments and clean fine quartz sand; *Amorphous*: few (<5%) sesquioxide nodules, sub-rounded, <500μm.

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