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Ancient Monuments Laboratory
Report 12/99

DENDROCHRONOLOGICAL ANALYSIS OF HALL I' TH' WOOD, BOLTON, GREATER MANCHESTER

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Summary

Hall I' Th' Wood is a timber-framed hall and cross-wing structure with two later stone extensions. Dendrochronological analysis was undertaken on 47 timbers associated with these three major structural elements. Seven timbers from the hall crossmatched to produce a tree-ring chronology dated to the period AD 1467-1569. A felling date range of AD 1578-1622 is indicated for the five timbers thought to be associated with the primary phase, suggesting a late-sixteenth century or early-seventeenth century construction date for the hall. The two other dated timbers, thought to be associated with later modification or repair phases, were felled after AD 1563 and after AD 1579 respectively. No dating evidence was produced for timber elements of the two stone extensions and no re-used timbers were identified by the analysis.

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DENDROCHRONOLOGICAL ANALYSIS OF HALL I' TH' WOOD, BOLTON, GREATER MANCHESTER

Introduction

This document is a technical archive report on the dendrochronological analysis of timbers from Hall I' Th' Wood, Bolton. It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. As part of a wider study of the building, elements of this report may be summarised and combined with detailed descriptions, drawings, and excavation records to form an extensive report on the building.

Hall I' Th' Wood (NGR: SO 72351160) is a grade I listed building currently under the ownership of Bolton Metropolitan Borough Council and in use as a museum. It lies approximately 2.0 km north of the centre of Bolton (Figs 1 and 2). It has recently been the subject of an archaeological survey both in advance of and during a major repair programme grant-aided by English Heritage (Thomas 1994 unpubl). Hall I' Th' Wood is considered of great historical interest because of its origins as a wool merchant's house in the late-fifteenth century and its later associations in the mid-eighteenth century with Samuel Crompton, inventor of the spinning mule, and at the turn of the nineteenth century with the eminent Boltonian, William Hesketh Lever, later Lord Lever and first Viscount Leverhulme (Thomas 1994 unpubl).

The extant structure consists of a timber-framed two-storied hall and cross-wing, with two stone-built additions on the north-west and south-west corners (Fig 3). The hall is a two-bayed structure and, although two storied, the height of the hall is greater than that of the other ground floor rooms in the cross-wing. This is thought to represent a transitional stage between the open hall and halls of the late-sixteenth and seventeenth centuries which were no higher than the other ground-floor rooms. The wall framing is of ornamental panels, based on square or small panels, and the east side and south-gable walls are jettied (Fig 4). The original location of the staircase is thought to be at the west side of the cross passage and hall, perhaps within a timber-framed turret. The roof throughout the hall and cross-wing is in general of post-and-truss construction with principal rafters, rafters, and ridge-and-trenched purlins, though the original construction is not necessarily easily distinguishable amongst the later alterations and repairs. On the evidence of architectural features the hall and cross-wing are thought to date to AD 1560-90. However the two-storied hall and cross-wing are thought to replace a house of similar type that consisted of an open hall and smaller cross-wing, probably of late-fifteenth century date (Thomas 1994 unpubl). Remnants of this earlier structure may survive in the form of re-used timbers scattered throughout the building. It has also been suggested tentatively that the framing and

main post in the cross-wing kitchen, room 2, east internal wall (Fig 3) is of a style more consistent with a date at the turn of the fifteenth century (Thomas and Smith pers comm).

The first major alteration is thought to be the reconstruction of the north and west walls of the cross-wing in stone, with the west wall probably being built further outwards. This seems to have preceded the addition of the stone extension on the north-west corner and the rebuilding in stone of the walls of the staircase turret at the west end of the cross-passage. The construction of the north-west wing appears to have been completed by AD 1591 if the datestone above the fireplace is to be believed, though there are doubts concerning its integrity. It is possible that this datestone was associated with the original fireplace of the timber-framed hall and was moved when the west wall of the hall was largely rebuilt in stone and the south-west stone extension added. These alterations are dated to AD 1648 based on both a datestone and architectural features.

The dendrochronological analysis was undertaken at the request of English Heritage in order to assist the archaeological survey. Its principal aim was to provide independent dating evidence for the three major constructional phases identified. However a secondary aim was to attempt to identify how extensive are the remains of the earlier late fifteenth-century house.

Methodology

The general practical and analytical techniques used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The following summarises relevant methodological details used for the dendrochronological analysis of this building.

Immediately prior to sampling an initial brief assessment survey was undertaken throughout the structure in order to identify the presence of timbers suitable for analysis and to allow a suitable sampling strategy to be formulated. Oak (*Quercus* spp.) is currently the only species used for routine dating purposes in the British Isles, though research on other species is being undertaken (eg Tyers 1998a; Groves 1997). Timbers with less than 50 annual growth rings are generally considered unsuitable for analysis as their ring patterns may not be unique (Hillam *et al* 1987). Thus oak timbers were sought which had at least 50 rings and if possible had either bark/bark edge or some sapwood surviving (see below). The sampling strategy was designed to take in as wide a range of structural elements throughout the three phases as possible and was discussed on site with both Angela Thomas and John Smith in order to ensure that there were no obvious omissions with respect to the current understanding of the building.

In standing buildings samples are generally removed from selected timbers in the form of either cross-sectional slices or cores. Slices are taken from timbers that are either wholly or partially replaced during restoration, whereas cores are removed from timbers that will remain *in situ*. The cores are taken, using a 15mm diameter corer attached to an electric drill, in a position and direction most suitable for maximising the numbers of rings in the sample, whilst ensuring the presence of sapwood and bark edge whenever possible.

The ring sequence of each sample was revealed by sanding until the annual growth rings were clearly defined. Any samples which fail to contain the minimum number of rings or have unclear ring sequences are rejected. The sequence of growth rings in the samples selected for dating purposes were measured to an accuracy of 0.01mm using a purpose built travelling stage attached to a microcomputer based measuring system (Tyers 1997a). The ring sequences were plotted onto semi-logarithmic graph paper to enable visual comparisons to be made between them. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. The Student's *t* test is then used as a significance test on the correlation coefficient and those quoted below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t* value of 3.5 or over is usually indicative of a good match (Baillie 1982, 82-5), provided that high *t* values are obtained at the same relative or absolute position with a range of independent sequences and that the visual match is satisfactory.

Dating is usually achieved by cross-correlating, or crossmatching, ring sequences within a phase or structure and combining the matching patterns to form a phase or site master curve. This master curve and any remaining unmatched ring sequences are then tested against a range of reference chronologies, using the same matching criteria as above. The position at which all the criteria are met provides the calendar dates for the ring sequence. A master curve is used for absolute dating purposes whenever possible as it enhances the common climatic signal and reduces the background noise resulting from the local growth conditions of individual trees.

During the crossmatching stage of the analysis an additional important element of tree-ring analysis is the identification of 'same-tree' timber groups. The identification of 'same-tree' groups is based on very high levels of similarity in both year-to-year variation, longer term growth trends, and anatomical anomalies. Such information should ideally be used to support possible 'same-tree' groups identified from similarities in the patterns of knots/branches during detailed recording of timbers for technological and woodland characterisation studies. Timbers originally derived from the same parent log generally

have *t* values of greater than 10.0, though lower *t* values do not necessarily exclude the possibility. It is a balance of the range of information available that provides the 'same-tree' link.

The crossdating process provides precise calendar dates only for the rings present in the timber. The nature of the final rings in the sequence determines whether the date of the youngest ring also represents the year the timber was felled. Oak consists of inner inert heartwood and an outer band of active sapwood. If the sample ends in the heartwood of the original tree, a *terminus post quem* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which may be missing. This is the date after which the timber was felled but the actual felling date may be many decades later depending on the number of outer rings removed during timber conversion. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. Alternatively, if bark-edge survives, then a felling date can be directly obtained from the date of the last surviving ring. In some instances it may be possible to determine the season of felling according to whether the ring immediately below the bark is complete or incomplete. However the onset of growth can vary within and between trees and this, combined with the natural variation in actual ring width, means that the determination of felling season must be treated with great caution. The sapwood estimate applied throughout this report is a minimum of 10 and maximum of 55 annual rings, where these figures indicate the 95% confidence limits of the range. This is a generally applicable estimate for the British Isles (Hillam *et al* 1987) though work in progress suggests that this range may be narrowed (Tyers pers comm).

The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the reuse of timbers and the repairs or modifications of structures, as well as factors such as stockpiling or seasoning, before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

The timber elements throughout all three phases were oak. The initial assessment of the *in situ* timbers indicated that the vast majority were unsuitable for dendrochronological dating purposes as they clearly contained insufficient numbers of rings. The conclusion from this initial assessment was supported by the subsequent assessment of a large number of timbers removed during the refurbishment prior to the dendrochronological assessment visit. There was also a notable lack of surviving bark edge and sapwood. A number of timbers considered important to the understanding of the structure had been

highlighted by John Smith (Figs 5 and 6; Table 1). Particularly detailed attention was given to these timbers during the assessment. Unfortunately many of these proved unsuitable as they clearly contained too few rings, whilst some could not be cored simply because the removal of a sample would compromise the structural integrity of the timber.

A series of thirteen timbers were selected for coring from the hall, cross-wing, and north-west wing. The location of these are indicated on copies of the plans drawn in 1993 by Butress Fuller Geoffrey Alsop Practice, architects and historic building consultants (Figs 7-13). No core samples were taken from the south-west wing because the roof trusses had been completely removed prior to the dendrochronological assessment. Two separate coring visits were undertaken in August and October 1995 as a result of access difficulties. A further 34 timbers were sampled, including a number of timbers not previously assessed, by the removal of cross-sectional slices which were delivered to the laboratory in October 1995. The majority of these timbers were tagged with a label giving information regarding their provenance. Unfortunately many of these were labelled some time after their removal from the structure and are therefore not as precise, nor indeed intelligible, as one would hope. Several timbers of unknown provenance within the building were also sampled as they were considered potentially useful for chronology building purposes.

Details of the 47 samples taken are given in Table 2. Twenty five samples were rejected either because they contained too few rings for reliable dating purposes or they contained bands of very narrow rings which could not be reliably measured. The uncertainty of the structural origin of several of the remaining 22 samples meant that they were analysed as a single large group rather than by the expected phasing.

The ring sequences of seven of the timbers, all from the hall, were found to match and were combined to form a 103-year master curve, BOLTON_HW (Fig 14; Tables 3 and 4). This was tested against an extensive range of dated reference chronologies spanning the last two millennia from the British Isles. It was immediately apparent that BOLTON_HW dated to the period AD 1467-1569 inclusive (Table 5).

The ring sequences from samples **7** and **12** crossmatched with a *t* value of 15.62 and were combined to produce a single sequence **7/12**. These slices were similarly labelled and are clearly duplicate samples from the same timber. This sequence and all remaining unmatched sequences were compared individually to the same extensive range of reference chronologies used above. No consistent results were obtained for any of these samples.

Interpretation

Five of the dated samples are thought to be associated with the original construction of the hall. The outermost ring of one of these samples (**102**) marks the heartwood/sapwood boundary and thus a felling date range of AD 1578-1623 is obtained. The outermost ring of **1** is also probably the heartwood/sapwood boundary which indicates that it was likely to have been felled in the period AD 1577-1622. The *termini post quem* for felling calculated for the three remaining samples are consistent with the combined felling date range of AD 1578-1622.

Evidence indicates that seasoning of timber was a fairly rare occurrence until relatively recent times and that timber was generally felled as required and used whilst green (eg Rackham 1990). Physical evidence for the rapid use of trees is widespread in buildings as many timbers show clear evidence of warping or splitting after having undergone conversion. Thus assuming that these dated timbers are all contemporary a construction date shortly after felling during the period AD 1578-1622 is implied for the hall.

Neither of the two remaining timbers (**5** and **113**) have retained any traces of sapwood. These were felled after AD 1579 and after AD 1563 respectively. **113** is a door jamb located in the west wall of the hall giving access to the stair turret and, although the dendrochronological results imply that this timber may be contemporary with the timbers associated with the construction of the hall, further information is required to determine whether it may have been associated with the alterations associated with the north-west wing extension. Timber **5** is an apparent repair to truss 3 and assuming that this has been correctly identified it is suggested that this repair is most likely to have occurred only shortly after the construction of the hall. The dendrochronological results indicate that it is certainly broadly contemporary with the other dated timbers but it has the latest dated ring from the site at AD 1569 which does not mark the heartwood/sapwood transition.

Discussion

Although the dendrochronological evidence broadly confirms the mid to late sixteenth-century construction date for the hall, the failure to refine this broad date range is disappointing. The lack of precision is the result of an absence of sapwood and bark edge throughout the building. This however should not have come as any surprise as it had been previously noted in a letter of 23rd Feb 1928 from the curator to the secretary of H M Office of Works in Westminster:

"*The roof timbers there are badly eaten by the death watch beetle and my Committee is now taking steps to remove or strengthen some of the spars, posts etc. The timber is oak and it is found that the*

corners of the beams etc., generally have a certain amount of sapwood at the angles. This had been most disintegrated and has been cut away to the sound heart wood."

The dendrochronological results are also disappointing in that they cannot confirm that the hall and cross-wing are the product of a single building campaign nor have they been able to produce any dating evidence for the timber elements of the two stone extensions. The analysis has not been able to identify any timbers which have clearly been re-used from the late fifteenth-century structure which was replaced by the extant building. However this does not necessarily exclude the possibility as these may simply be part of the unmatched and undated group of timbers.

The low success rate, only seven crossmatched and dated samples from 22 measured sequences, is likely to be due in part to the relative shortness of the ring sequences and also the adverse affect of bands of narrow rings and erratic growth (Fig 15) which mask the common climatic signal required for successful dating. Sample **4** is a notable exception as far as sequence length is concerned but its growth pattern also shows sudden disruptions (Fig 15). Narrow bands of rings resulted in several otherwise suitable samples being rejected as the ring boundaries were not sufficiently clearly defined to allow precise and reliable measurement (eg **18**). The possible causes of sudden growth reduction include management regimes, or at least some form of human intervention such as pollarding or shredding, localised defoliation by pests, possible responses to flooding, or more generalised environmental factors such as severe weather conditions. No definitive answer can be provided from the tree-ring analysis. This highlights the growing need for research on the effects of anthropogenic and environmental factors on modern trees under known conditions. This would allow better understanding of the responses noted in the ring patterns and the anomalies seen within individual rings of archaeological timbers. The current increased interest in renewing former management practices in woodlands provides a potentially ideal opportunity for such research to be carried out.

The dendrochronological results (Tables 3 and 5) do nevertheless indicate that this is probably a coherent single-source group of timbers likely to have been obtained from local woodlands. The name Hall I' Th' Wood was presumably appropriate in its earlier history, though it is now surrounded by modern housing rather than woodland. It was located in part of a much larger ancient forest, mainly oak, which covered the surrounding countryside (Mills 1992). Whether the timbers used in the construction of the building were actually drawn from the surrounding woodland cannot be proven from the dendrochronological analysis, but such information may sometimes be traceable in documentary records. The final demise of the woodland around Hall I' Th' Wood appears to be associated with the Industrial Revolution when many of the forest trees were cut down in the late-eighteenth and early-

nineteenth centuries, mainly for the construction of mill buildings and associated structures for the rapidly developing cotton industry (Mills 1992).

Conclusion

The dendrochronological evidence supports the suggested construction date for the hall and cross-wing of AD 1560-90, indicated by architectural and documentary information, but has been unable to significantly refine it. No evidence has been provided for the presence of re-used timbers from a hypothetical late fifteenth-century structure that the present structure is thought to have replaced. No dating evidence has been produced for timber element from either of the two stone extensions.

The relative shortness of the ring sequences and the frequency of bands of very narrow rings must be major contributory reasons to the poor success rate as far as the dating of individual samples is concerned. Such problems are not unusual in the later medieval period and may be a reflection of increased or more organised management of the woodland resource.

Acknowledgements

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References

Baillie, M G L, 1982 *Tree-Ring Dating and Archaeology*, London

Baillie, M G L, and Pilcher, J R, 1973 A simple crossdating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7-14

Boswijk, G, and Hillam, J, 1997 *Tree-ring analysis of timbers from Lands Head Farm, Northowram, West Yorkshire*, ARCUS Rep, **330**

English Heritage, 1998 *Dendrochronology - guidelines on producing and interpreting dendrochronological dates*, London

Groves, C, 1997 The dating and provenancing of imported conifer timbers in England: the initiation of a research project, in *Archaeological Sciences 1995: proceedings of a conference on the application of scientific methods to archaeology* (eds A Sinclair, E Slater, and J Gowlett), Oxbow Books Monogr Ser, **64**, 205-11

Groves, C, 1998 *Dendrochronological analysis of Lightshaw Hall, Golborne, Greater Manchester*, Anc Mon Lab Rep, **77/98**

Hillam, J, 1984 *Tree-ring analysis of timbers from Elland Old Hall, West Yorkshire*, Anc Mon Lab Rep, **4165**

Hillam, J, Morgan, R A, and Tyers, I, 1987 Sapwood estimates and the dating of short ring sequences, in *Applications of tree-ring studies: current research in dendrochronology and related areas* (ed R G W Ward), BAR Int Ser, **333**, 165-85

Leggett, P A, 1980 *The use of tree-ring analyses in the absolute dating of historical sites and their use in the interpretation of past climatic trends*, unpubl PhD Thesis, CNAA (Liverpool Polytechnic)

Miles, D H, and Haddon-Reece, D, 1993 List 54 - Shropshire Dendrochronology Project, *Vernacular Architect*, **24**, 54-60

Mills, D R, 1992 *A short history of Hall i' th' Wood of Bolton, Lancashire and its occupants circa 1483 to the present*, Bolton

Morgan, R A, 1980 Tree-ring dates for buildings - List 1, *Vernacular Architect*, **11**, 22

Munro, M A R, 1984 An improved algorithm for crossdating tree-ring series, *Tree Ring Bulletin*, **44**, 17-27

Nayling, N, 1998 *Dendrochronological analysis of timbers from Old Abbey Farm, Risley, Cheshire*, ARCUS Rep, **412**

Rackham, O, 1990 *Trees and woodland in the British Landscape*, 2nd edn, London

Thomas, A P, 1994 unpubl *Hall I'Th' Wood, Bolton: The history and development of the building - an initial study*, Bolton Museum and Art Gallery

Thomas, A P, no date *Hall I'Th' Wood,* Bolton Museum and Art Gallery

Tyers, I, 1997a *Dendro for Windows program guide*, ARCUS Rep, **340**

Tyers, I, 1997b *Tree-ring analysis of timbers from Sinai Park, Staffordshire*, Anc Mon Lab Rep, **80/97**

Tyers, I, 1998a Beech dendrochronology, in *Magor Pill medieval wreck* (N Nayling), CBA Res Rep, **115**, 123-8

Tyers, I, 1998b *Tree-ring analysis of oak timbers from Penrhos Court, near Kington, Herefordshire*, Anc Mon Lab Rep, **31/98**

Figure 1: Map to show the general location of Hall I' Th' Wood, Bolton

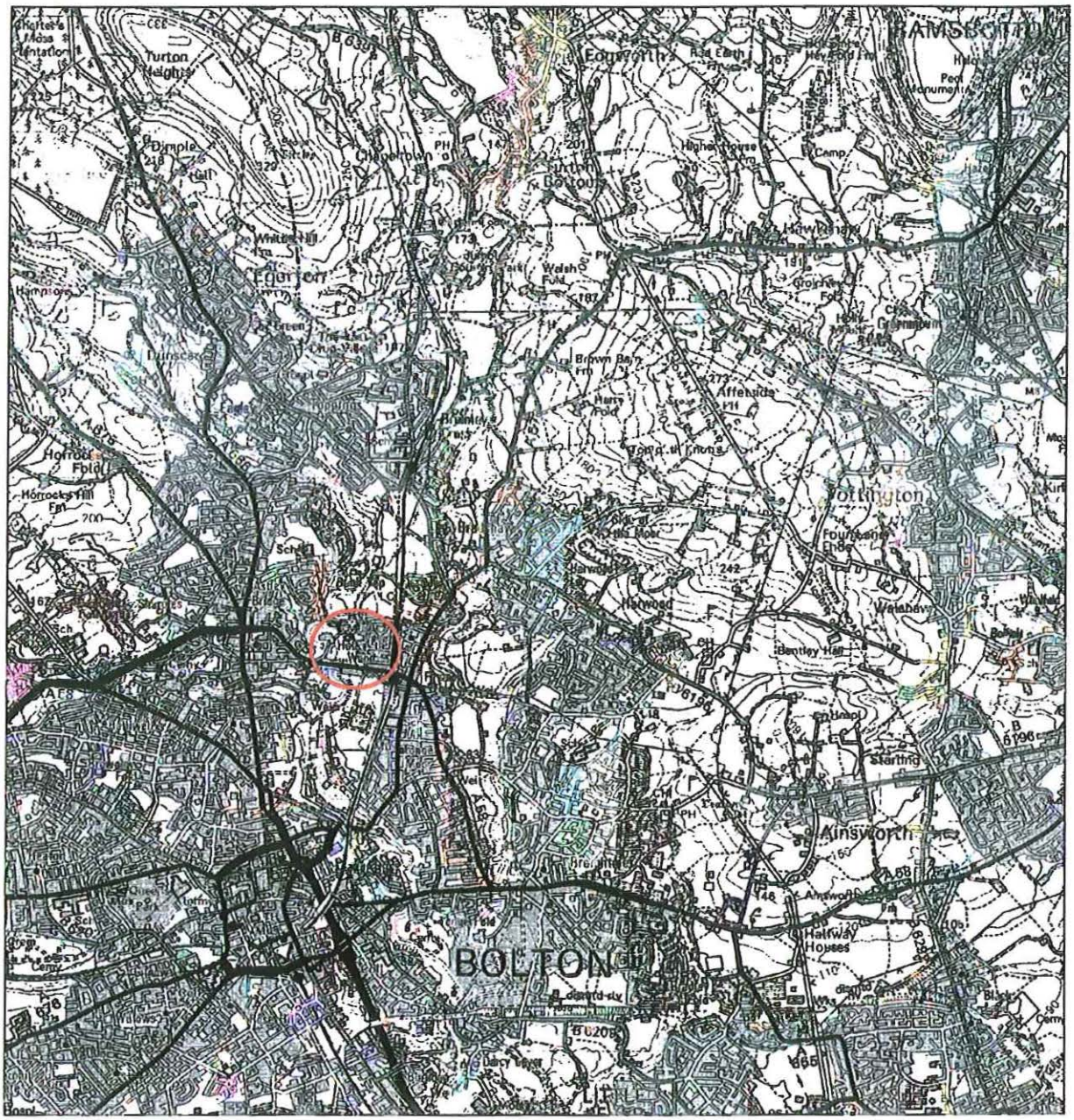


Figure 2: Town plan to show the particular location of Hall I' Th' Wood, Bolton.

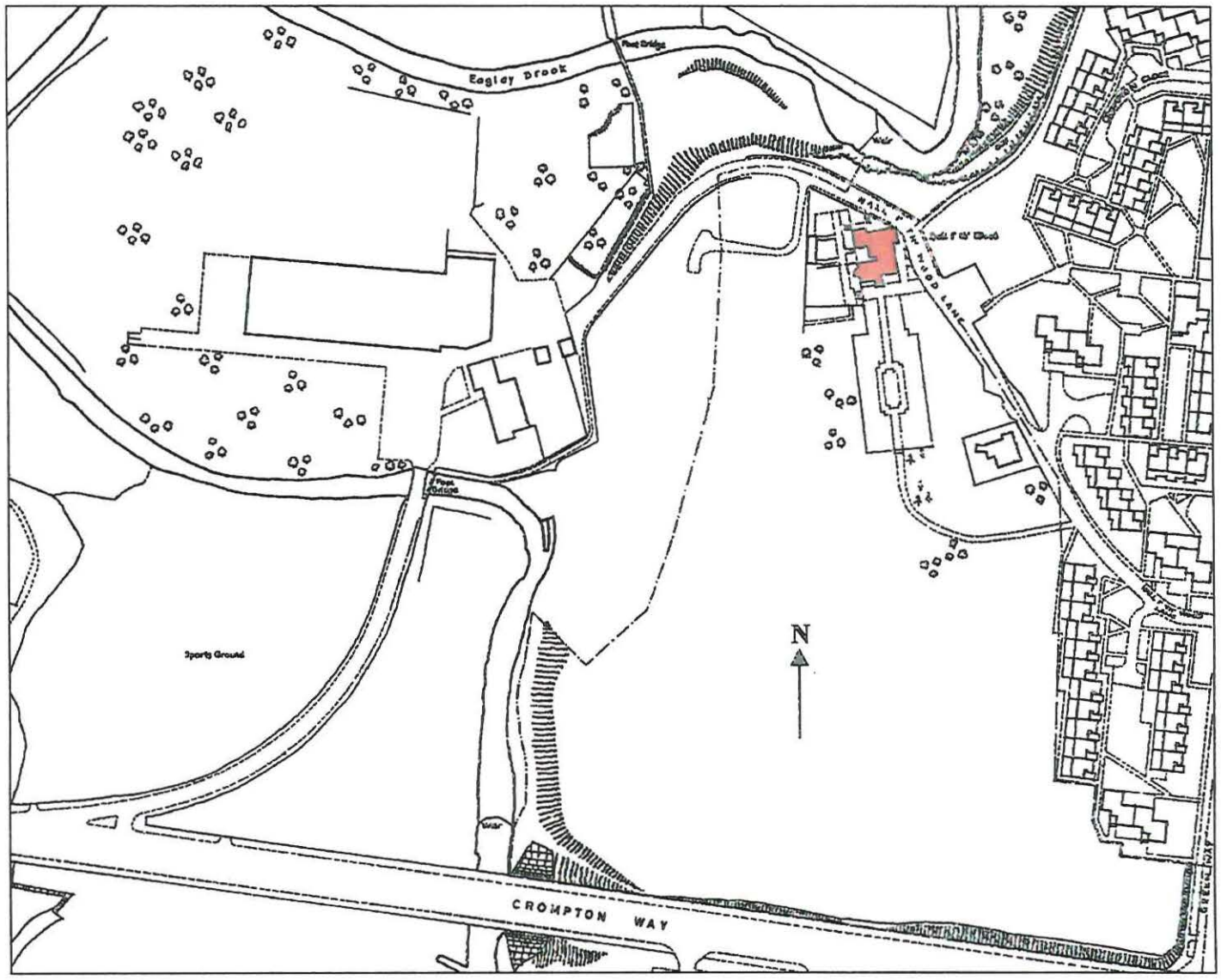


Figure 3: Ground floor plan of Hall I' Th' Wood, after Thomas (nd). The hall and cross-wing are rooms 1, 2, and A; north-west wing room 3; south-west wing room 10.

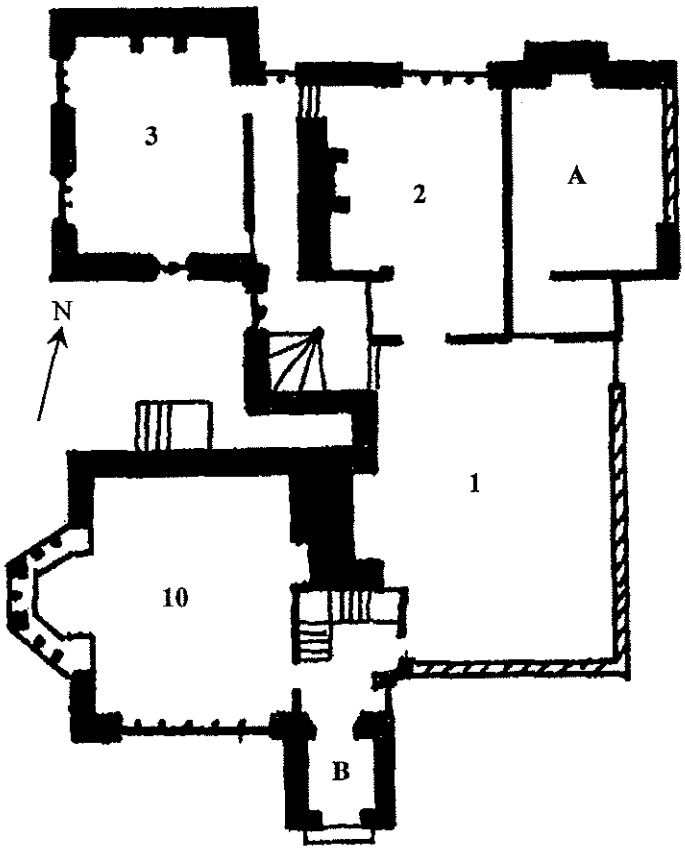
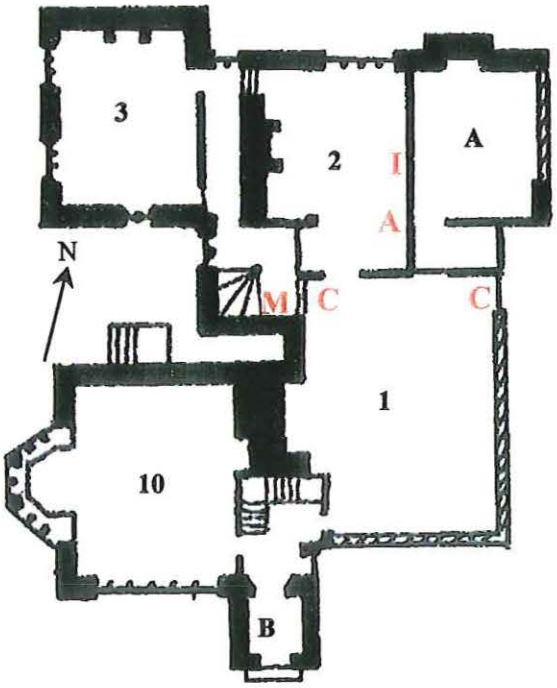
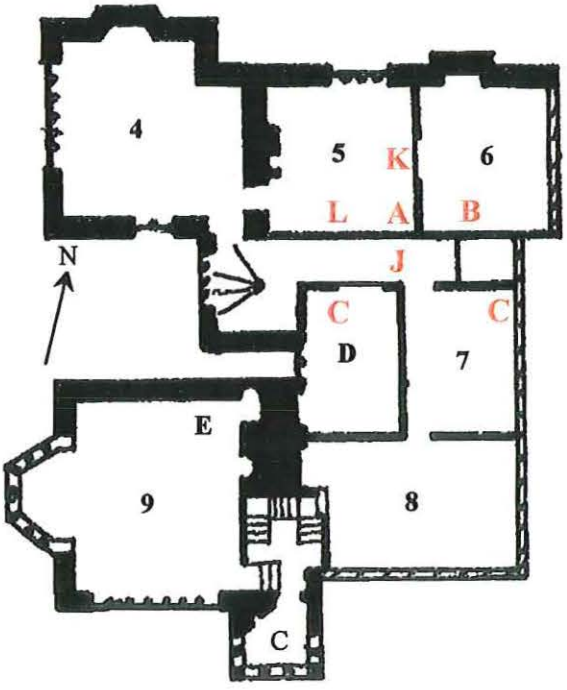


Figure 4: Hall I' Th' Wood, *circa* AD 1900, viewed from the south-east, reproduced from Mills 1992.

Figure 5: Ground floor and first floor plans of Hall I' Th' Wood, after Thomas (nd), showing the approximate location of timbers (eg I) indicated by Smith for sampling.



GROUND FLOOR PLAN



FIRST FLOOR PLAN

Figure 6: Second floor plan of Hall I' Th' Wood showing the approximate location of timbers (eg G) indicated by Smith for sampling. Truss numbers are also shown.

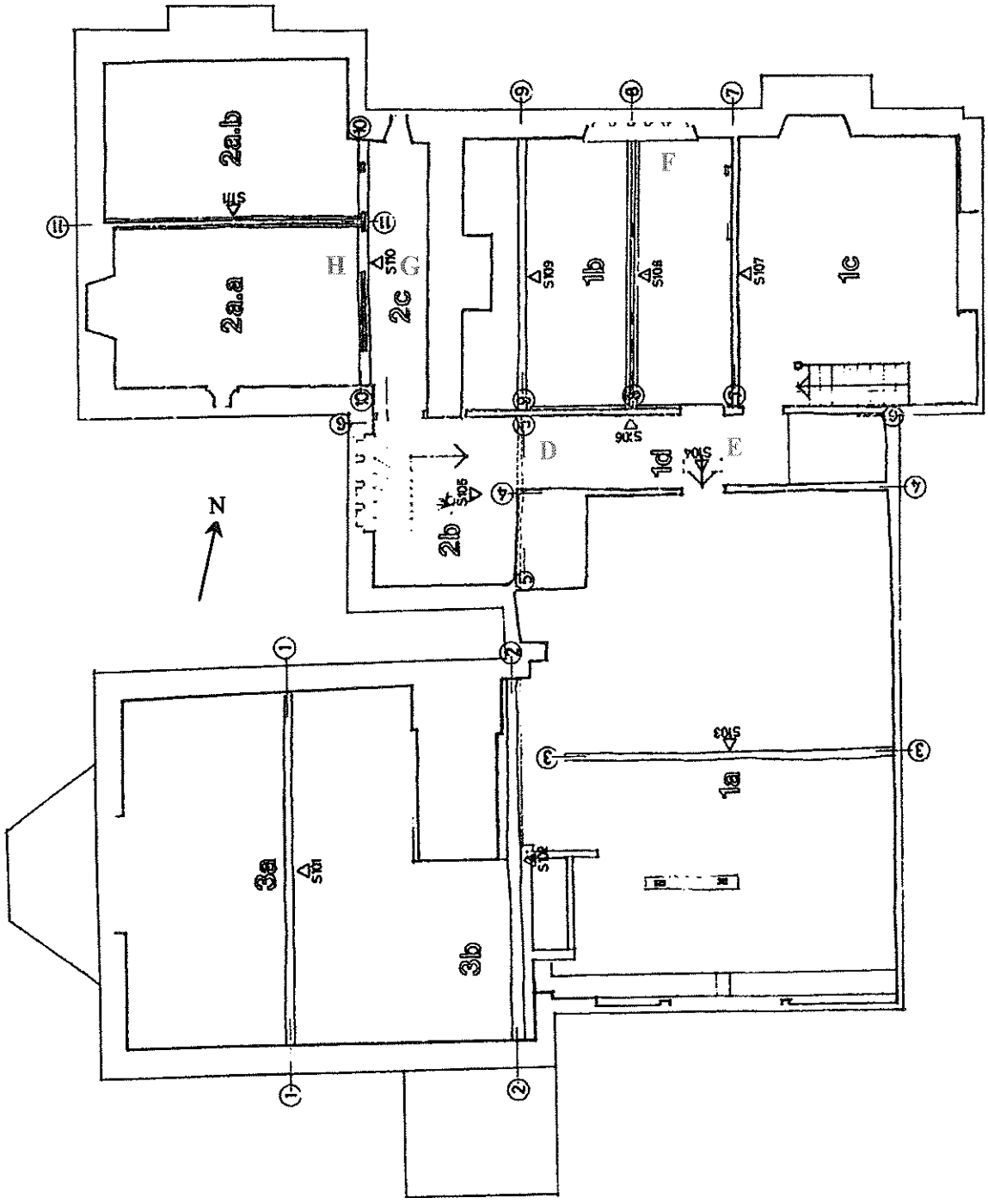


Figure 7: The ground floor plan of Hall I' Th' Wood showing the approximate location of core samples **112** and **113**.

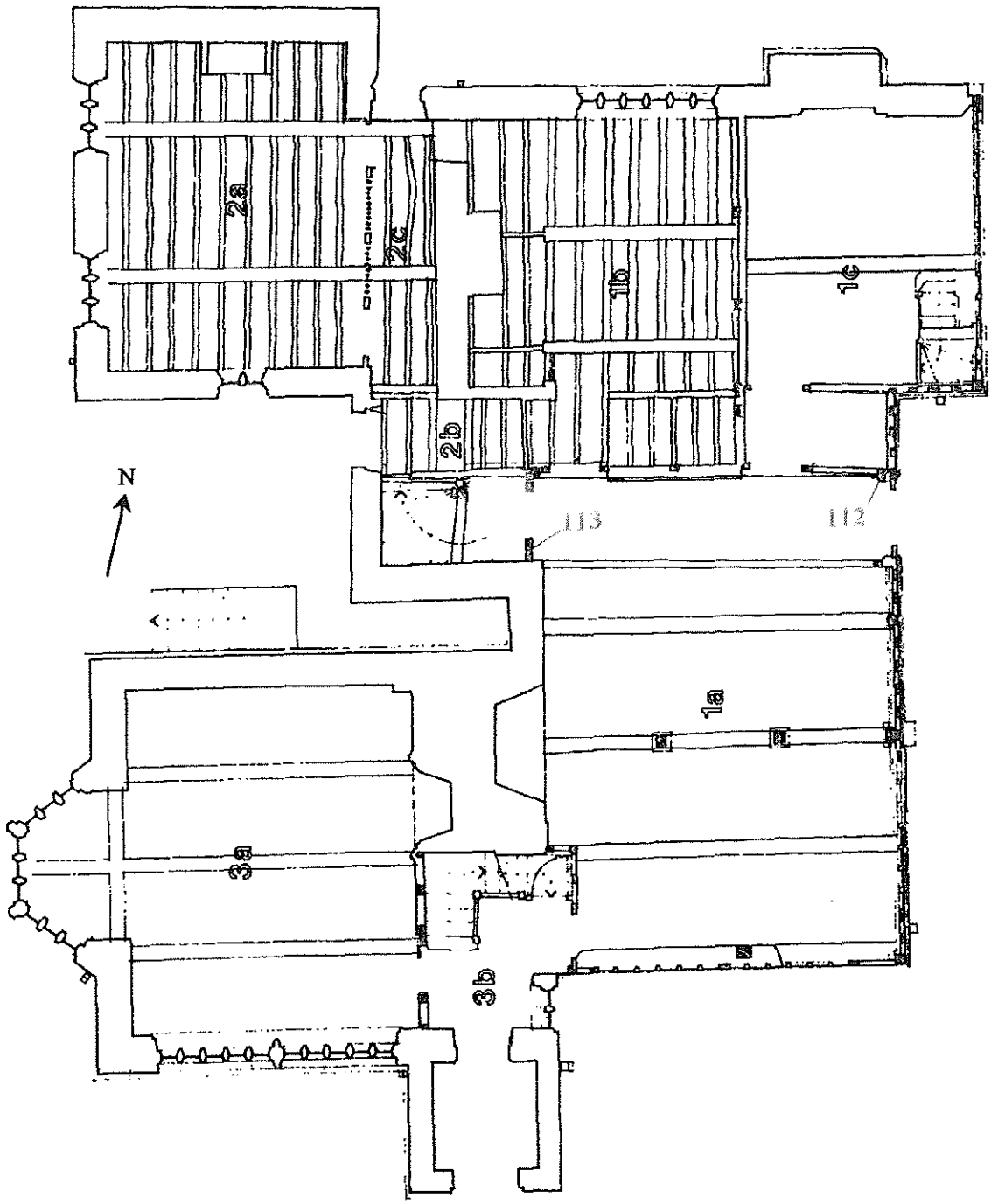


Figure 8: The first floor plan of Hall I' Th' Wood showing the approximate location of core sample **111**.

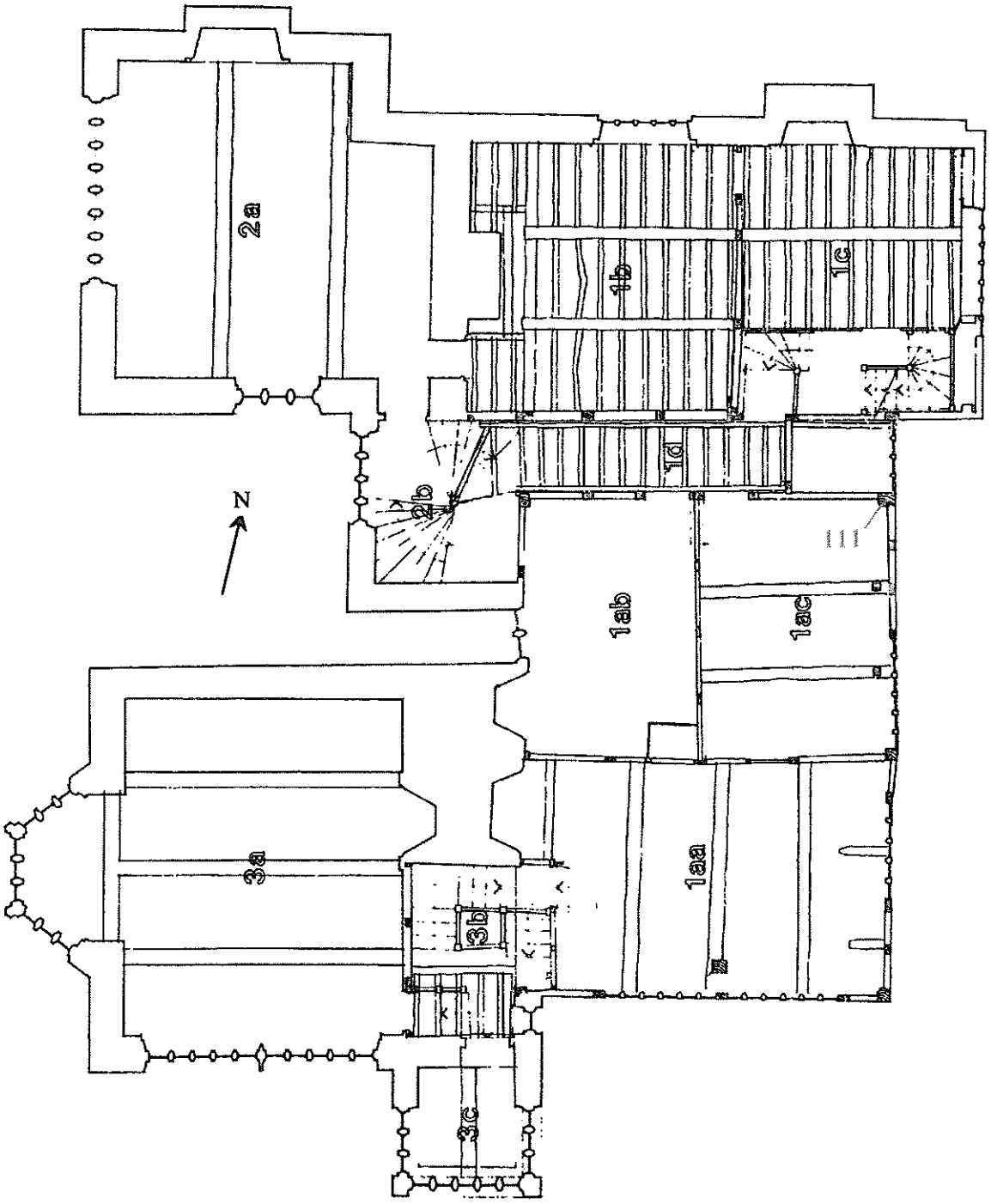


Figure 9: The ground floor plan of Hall I' Th' Wood showing the approximate location of core samples **101-110** inclusive.

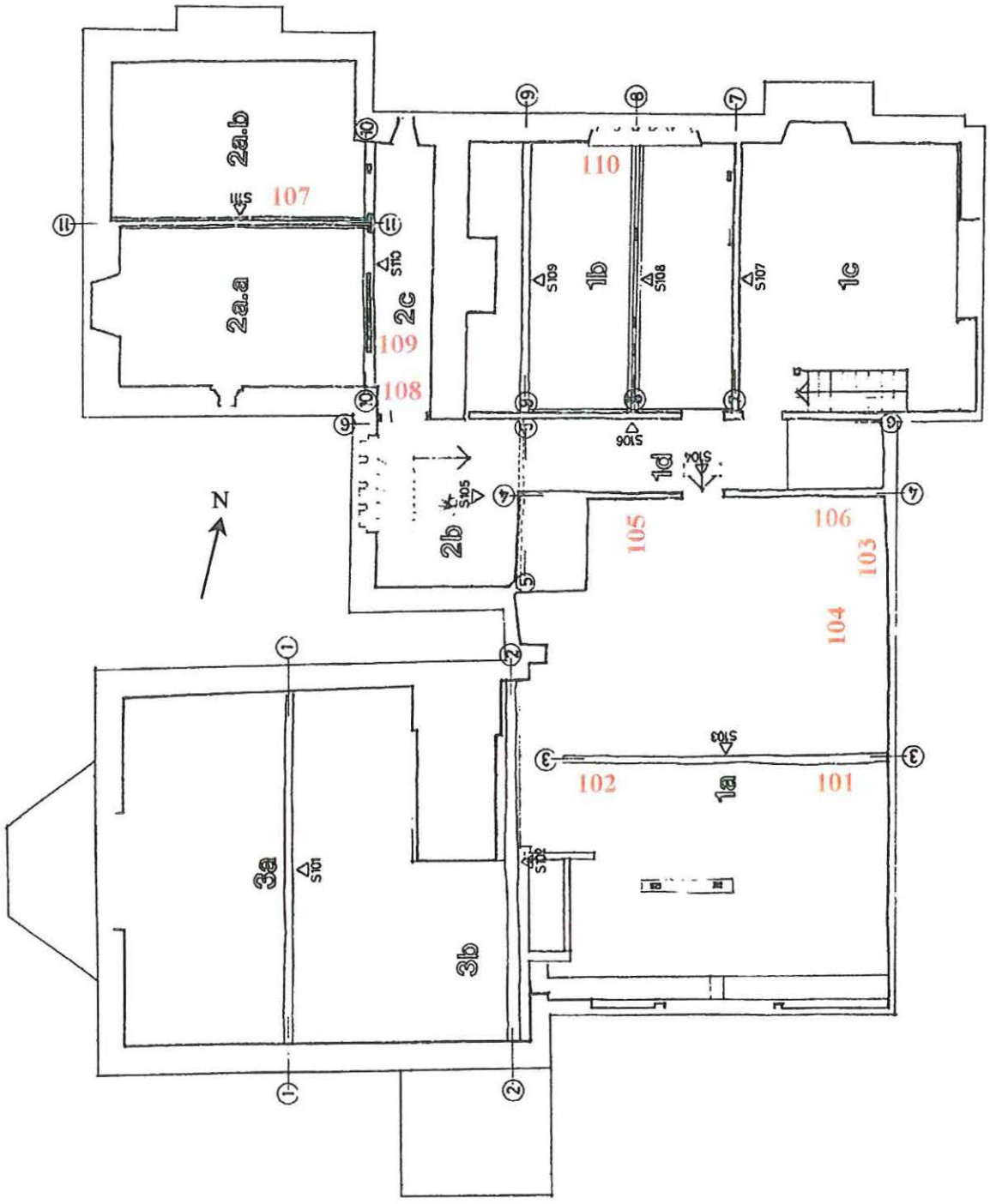


Figure 10: The north face of truss 3 showing the approximate location of samples **101** and **102**.

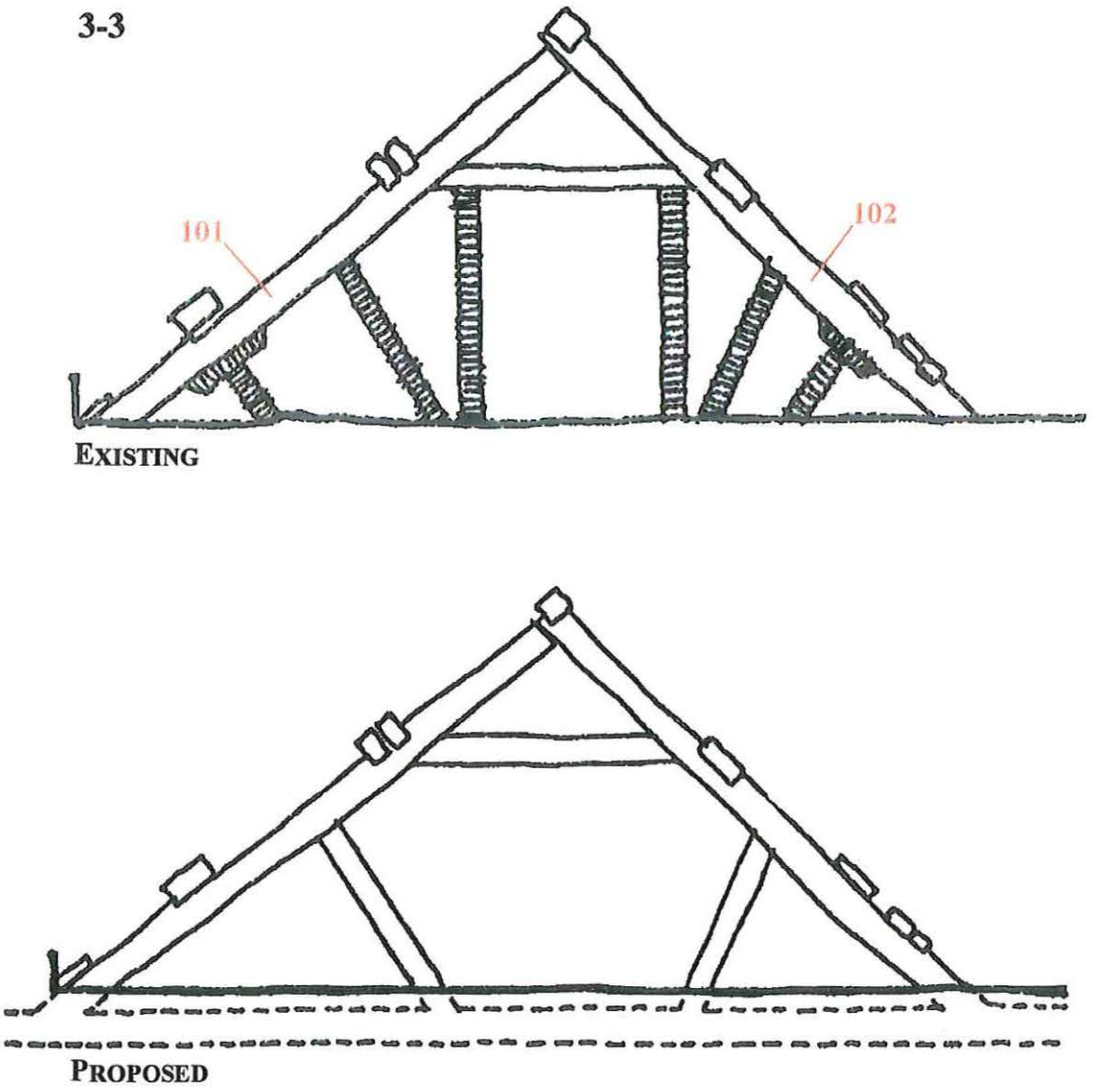


Figure 11: The north face of truss 4 showing the approximate location of samples 103-106 inclusive.

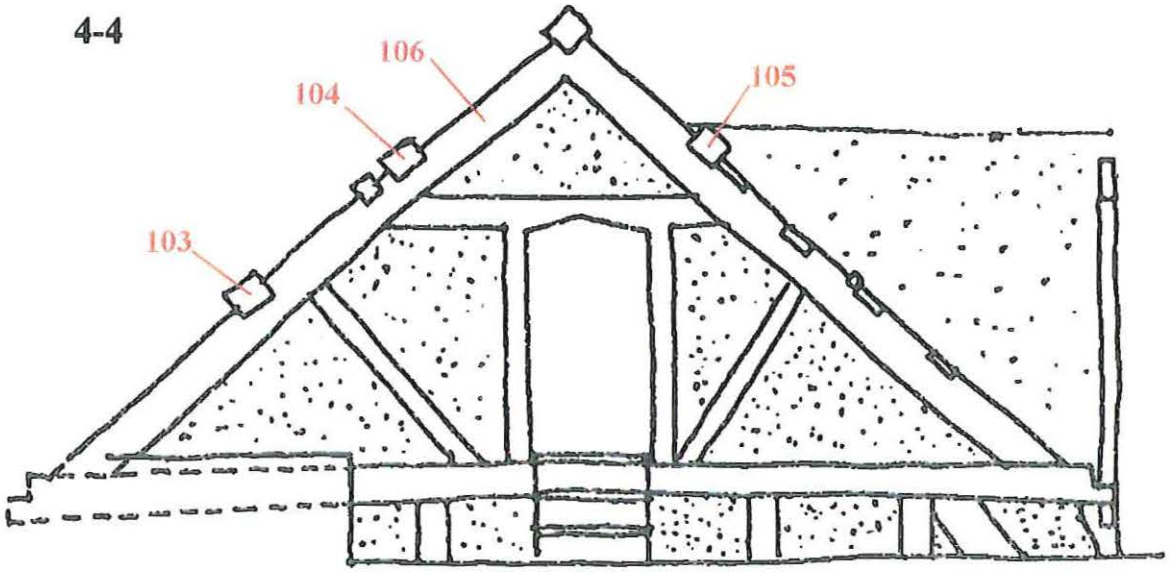
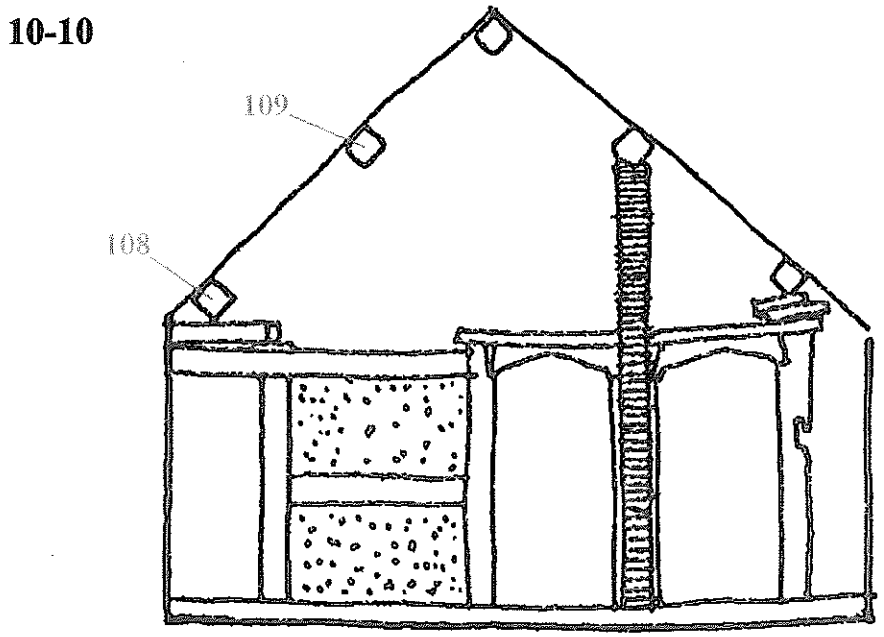


Figure 12: The east face of truss 10 showing the approximate location of samples **108** and **109**.



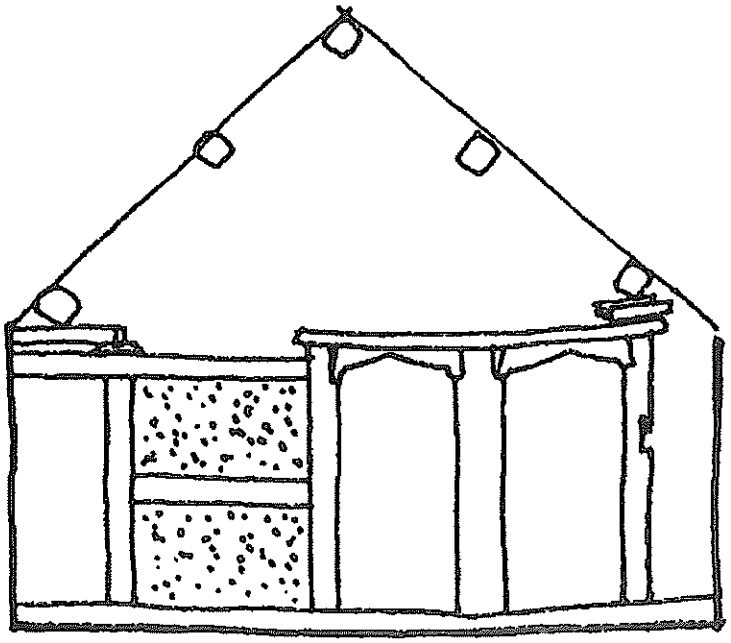


Figure 13: The north face of truss 11 showing the approximate location of sample 107.

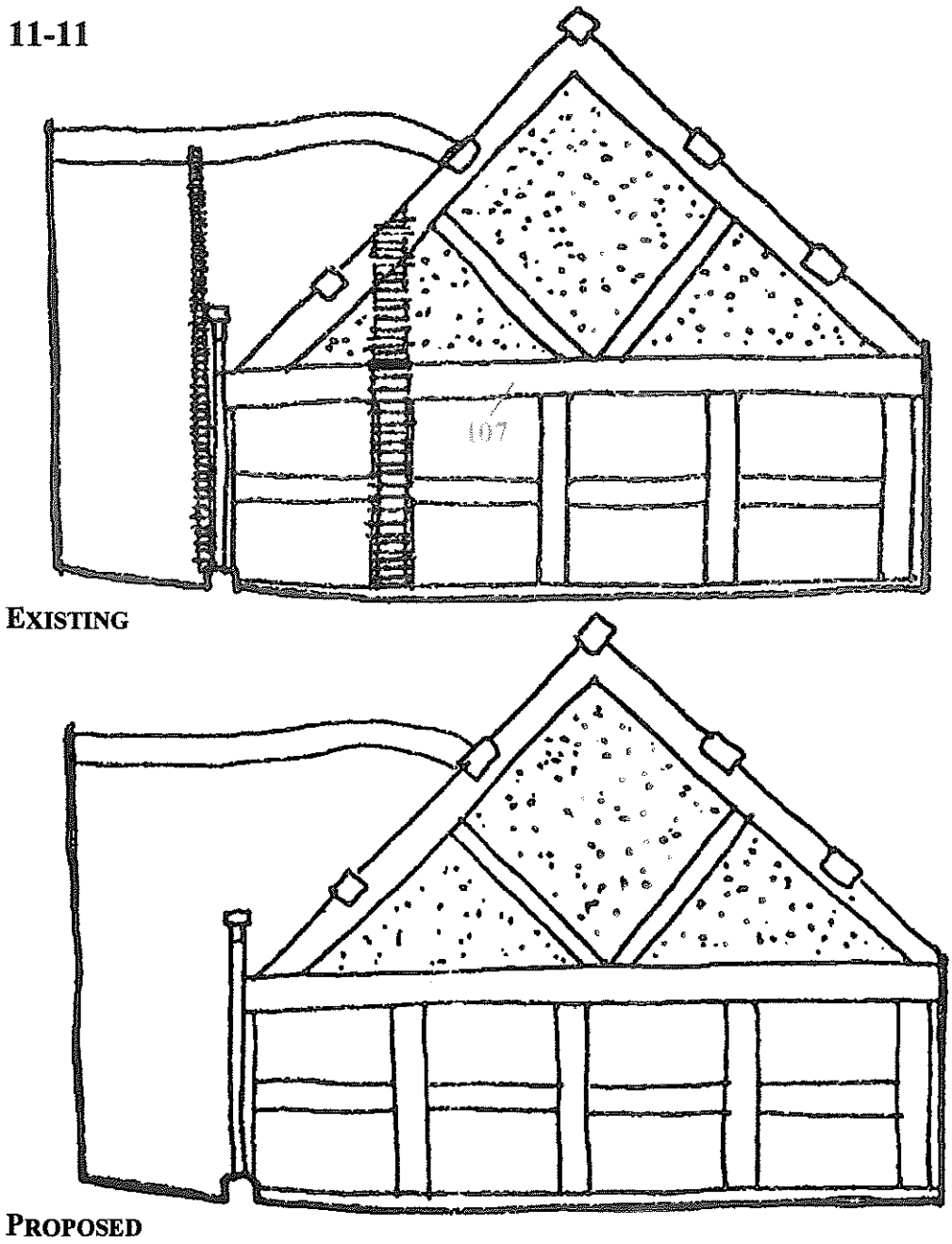
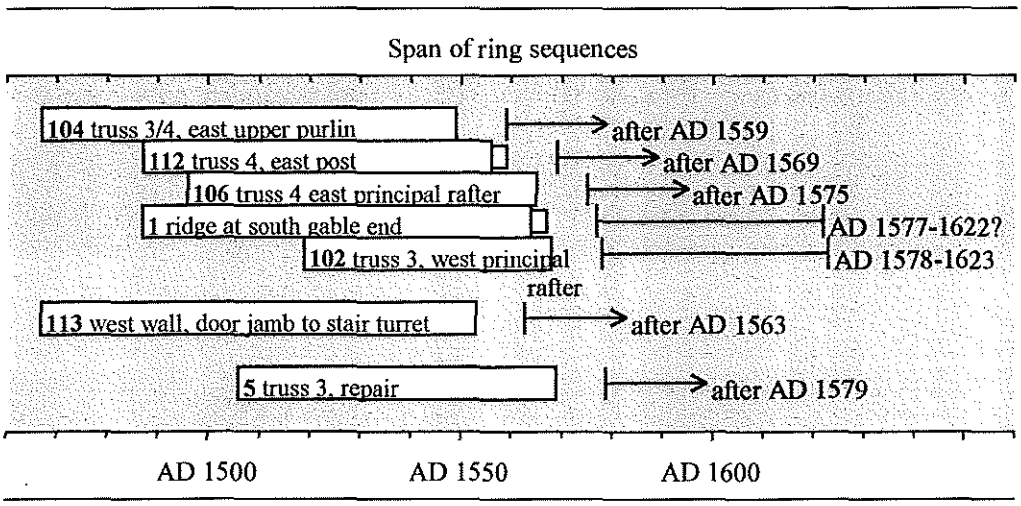
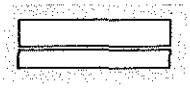


Figure 14: Bar diagram showing the relative positions of the dated ring sequences from the hall and their associated felling dates.



KEY



heartwood
unmeasured heartwood

Figure 15: The ring sequences from a selection of samples showing the incidence of bands of narrow rings where growth is suddenly retarded. All samples are aligned to start at year 1. **5** and **113** are dated but the rest remain undated.

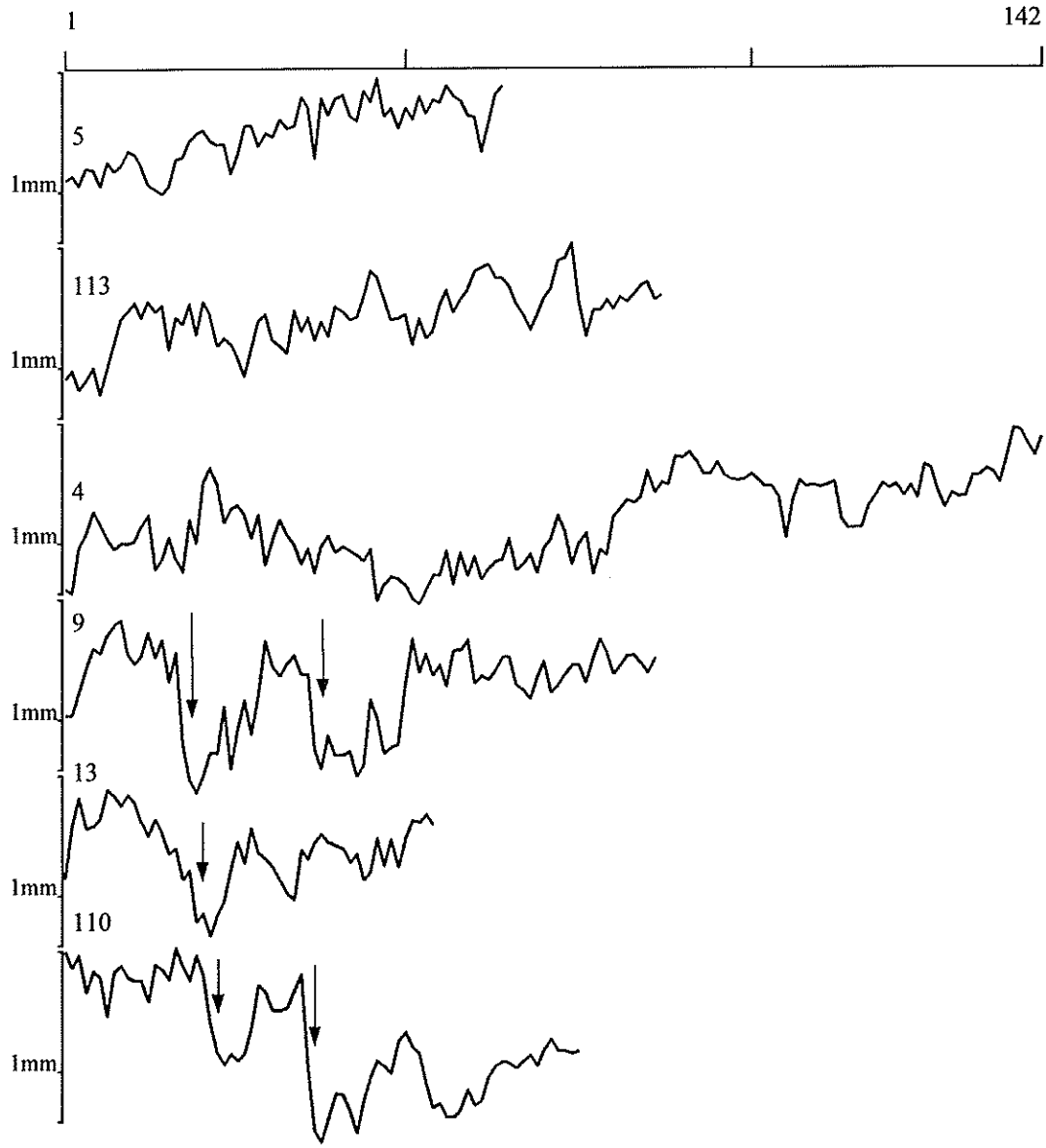


Table 1: List of timbers that John Smith hoped would be suitable for coring, the locations of which are indicated on Figures 5 and 6.

Timber code	Description
A	Kitchen post on stylobate and upper part above in room 5
B	Framing in cupboard under stairs on first floor landing above office
C	Two corner posts at north end of hall and upper parts above
D	Reused timbers between hall and cross wing in roof
E	Roof passage double door jamb and truss above
F	North wall of attic over kitchen, wall plate over window
G	Purlins linking 1591 building and gable of kitchen wing which appear reused
H	1591 partition in roof
I	Framework of inner east kitchen wall part way along
J	First floor passage on north side, wall of crosswing
K	Room 5 over kitchen, east wall above the rail/wall plate
L	Room 5 south wall, wall plate
M	Framing of doorway from hall leading to spiral staircase

Table 2: Details of the samples from Hall I' Th' Wood, Bolton.

Number of rings - total number of measured rings including both heartwood and sapwood
+ - unmeasured rings; hs - heartwood/sapwood boundary; bs - bark edge present, felled summer
b - bark edge present, felling season indeterminate; ~ - approximately
AGR - average growth rate in millimetres per year
cross-section size - maximum dimensions of the cross-section in millimetres
cross-section type - guide to conversion type

Sample	Range	Timber function /location	Wood type	Sample type	Total number of rings	Sapwood rings	AGR	Cross-section dimensions	Cross-section type	Date of measured ring sequence	Comment
1	Hall	Roof 1, ridge between roof 5 to gable	oak	slice	78 *+3*	-	1.63	200 x 185	whole	AD 1487-1564	-
2	Stair turret	Truss 5, principal back	oak	slice	56	4	2.26	205 x 120	whole	-	-
3	Hall	Room 1, framing	oak	slice	95	28 bs	1.96	245 x 195	halved	-	-
4	Hall	Room 1, east wall jetty	oak	slice	142	-	1.54	175 x 140	quartered	-	-
5	Hall	Truss 3, repair	oak	slice	64	-	2.30	110 x 105	quartered	AD 1506-1569	-
6	Hall?	?East wall jetty	oak	slice	66	-	2.16	120 x 90	quartered	-	-
7	Cross-wing	Roof 2, east valley	oak	slice	56	-	2.13	155 x 135	whole	-	-
8	Hall	Room 1, window frame east pike	oak	slice	67	-	2.34	160 x 100	quartered	-	-
9	Hall	Room 1, partition 6 north wall	oak	slice	86	?hs	1.69	180 x 115	halved	-	-
10	South-west wing	Truss 1, tiebeam	oak	slice	53*+13b*	5 *+13b*	2.72	235 x 150	halved	-	-
11	North-west wing	Roof 3, purlin A1	oak	slice	56	10	2.11	205 x 170	whole	-	-
12	Cross-wing	East roof valley	oak	slice	54	-	2.16	150 x 95	halved	-	-
13	North-west wing	Roof 2, over G B2 north	oak	slice	54	-	1.98	145 x 125	halved	-	-
14	?Hall	South elevation, WF15 post	oak	slice	48	-	3.10	150 x 115	quartered	-	rejected
15	?	unlabelled	oak	slice	48	hs	1.50	145 x 70	halved	-	rejected
16	?	Spar 9A south	oak	slice	40	-	2.70	120 x 65	quartered	-	rejected
17	Hall	Room 1, window frame east pike	oak	slice	~65	-	2.00	155 x 110	halved	-	rejected, rings badly distorted, bands of very narrow unmeasurable rings
18	?	Window frame south wall	oak	slice	~55	-	2.90	200 x 115	halved	-	rejected, bands of very narrow unmeasurable rings
19	South-west wing	Roof 5, purlin A near WS07	oak	slice	30	hs	2.50	150 x 135	whole	-	rejected
20	Cross - wing	North wall, wall plate	oak	slice	~40	4	3.90	210 x 155	halved	-	rejected, bands of very narrow unmeasurable rings
21	South-west wing	Roof 5, B2 purlin	oak	slice	30	-	4.00	215 x 185	whole	-	rejected
22	Cross-wing	Roof 2, B2 south	oak	slice	~50	5	-	220 x 180	whole	-	rejected, double centred, rings badly distorted
23	South-west wing	Roof 5, purlin B1 south	oak	slice	31	-	3.20	180 x 175	whole	-	rejected
24	Cross-wing	Roof 2, B2 south over truss 9	oak	slice	26	3	4.00	175 x160	whole	-	rejected

Table 2: (cont)

Sample	Range	Timber function /location	Wood type	Sample type	Total number of rings	Sapwood rings	AGR	Cross-section dimensions	Cross-section type	Date of measured ring sequence	Comment
25	Hall	Room 1, east wall jetty	oak	slice	34	-	4.70	190 x 145	whole	-	rejected
26	Hall	Roof 1, west side purlin	oak	slice	27	2	3.70	170 x 165	whole	-	rejected
27	Cross-wing	Roof 2, north A1	oak	slice	19	-	6.30	180 x 120	halved	-	rejected, duplicate of 29
28	Cross-wing	Roof 2, north elevation wall plate north east corner	oak	slice	~60	-	1.60	165 x 160	whole	-	rejected, rings badly distorted, bands of very narrow unmeasurable rings
29	Cross-wing	Roof 2, north A1	oak	slice	21	-	6.40	165 x 165	halved	-	rejected, duplicate of 27
30	?	unlabelled	oak	slice	~70	-	2.30	165 x 150	halved	-	rejected, severe degradation prevented precise ring boundary recognition
31	?	unlabelled	oak	slice	58	hs	1.98	180 x 175	whole	-	-
32	?	unlabelled	oak	slice	50	hs	2.00	195 x 155	whole	-	-
33	?	unlabelled	oak	slice	~45	~5	3.90	180 x 85	quartered	-	rejected, severe degradation prevented precise ring boundary recognition
34	?	unlabelled	oak	slice	52	-	1.87	110 x 75	quartered	-	-
101	Hall	Truss 3, east principal rafter	oak	core	45	-	3.20	255 x 120	halved	-	rejected
102	Hall	Truss 3, west principal rafter	oak	core	50	-	3.05	265 x 120	halved	AD 1519-1568	-
103	Hall	Truss 3/4, east lower purlin	oak	core	48	-	3.30	330 x 160	halved	-	rejected
104	Hall	Truss 3/4, east upper purlin	oak	core	83	-	1.69	325 x 125	halved	AD 1467-1549	-
105	Hall	Truss 4/8, purlin to apex of 108	oak	core	-	-	-	230 x 230	halved	-	rejected, shattered during coring
106	Hall	Truss 4, east principal rafter	oak	core	70	-	2.14	245 x 120	halved	AD 1496-1565	-
107	North-west wing	Truss 11, top east-west beam in studding	oak	core	24	hs	4.80	315 x 235	whole	-	rejected
108	Cross-wing	Truss 10/west wall, south lower purlin	oak	core	41	8	2.00	-	whole	-	rejected
109	Cross-wing	Truss 10/west wall, south upper purlin	oak	core	47	-	1.50	-	whole	-	rejected
110	Cross-wing	Truss 8/9, wall plate	oak	core	75	-	1.90	-	whole	-	-
111	Hall	Truss 4, room 7 north east post	oak	core	47	-	2.60	-	-	-	rejected
112	Hall	Truss 4, room 1 north east post	oak	core	70 +3	-	2.13	-	-	AD 1487-1556	-
113	Hall	room 1 west wall, northern door, door jamb	oak	core	87	-	2.09	-	-	AD 1467-1553	-

Table 3: Matrix showing the *t* values obtained between the matching ring sequences.

\ = overlap < 15 years
\- = *t* -values < 3.00

Sample	5	102	104	106	112	113
1	-	5.56	-	-	4.24	5.12
5		-	4.12	6.75	4.83	-
102			3.09	-	-	3.95
104				3.49	5.66	5.41
106					3.68	-
112						-

Table 4: The ring width data from the site master chronology, BOLTON-HW, dated AD 1467-1569 inclusive.

Date	Ring widths (units of 0.01mm)										Number of samples									
AD 1467							149	121	91	107							2	2	2	2
	129	118	152	262	296	241	226	211	281	251	2	2	2	2	2	2	2	2	2	2
	230	183	230	215	248	177	282	208	186	203	2	2	2	2	2	2	4	4	4	4
	127	114	124	152	201	245	156	159	177	202	4	4	4	4	4	5	5	5	5	5
AD 1501	181	217	171	262	224	228	209	180	211	188	5	5	5	5	5	6	6	6	6	6
	209	204	159	161	143	164	121	149	181	200	6	6	6	6	6	6	6	6	7	7
	234	257	241	259	249	258	265	272	247	213	7	7	7	7	7	7	7	7	7	7
	233	233	187	142	198	227	251	261	254	358	7	7	7	7	7	7	7	7	7	7
	213	125	232	225	217	194	191	197	243	235	7	7	7	7	7	7	7	7	7	6
AD 1551	280	205	217	167	205	207	227	216	262	197	6	6	6	5	5	5	4	4	4	4
	248	224	222	196	213	147	185	259	398		4	4	4	4	3	2	2	2	1	

Table 5: Dating the site master chronology, BOLTON-HW. Results of comparisons between some relevant reference chronologies and BOLTON-HW at AD 1467-1569 inclusive. All reference chronologies are independent.

Region	Reference chronology	*t* value
Cheshire	Old Abbey Farm 2, Risley (Nayling 1998)	6.48
Greater Manchester	Lightshaw Hall 2, Golborne (Groves 1998)	5.58
	Peel Hall 2, Manchester (Leggett 1980)	6.25
Herefordshire	Penrhos Court 2, Kington (Tyers 1998b)	6.55
Lancashire	Clayton Hall, Preston (Leggett 1980)	6.47
Shropshire	Brookgate Farm, Plealy (Miles and Haddon-Reece 1993)	5.18
Staffordshire	Sinai Park (Tyers 1997b)	5.93
West Yorkshire	Elland Old Hall (Hillam 1984)	5.04
	Lands Head Farm, Northowram (Boswijk and Hillam 1997)	5.55
Wales	Llanigon, Lower Wenallt (Morgan 1980)	5.54