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Wood Stone, Plaster and Polychromy
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PETERBOROUGH CATHEDRAL: THE NAVE CEILING

PHASE 2: ROWS 28 - 35

CONDITION SURVEY AND CONSERVATION TREATMENT

MAY - JULY 1999

VOLUME I TEXT AND GRAPHICS

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ABSTRACT

This report is a record of treatment carried out from May/August 1999 to Bays 2 and 3 of the Nave Ceiling: *Panels 28/35 I/II/III/IV* and associated Ashlar boards. Included in this report is a detailed written, graphic and photographic condition survey and treatment record of both the Ceiling structure and painted decoration; references to previous recorded treatment and investigations; a record of tests conducted as a preliminary to this treatment phase; and observations and findings made during the condition survey and treatment.

ACKNOWLEDGEMENTS

The Perry Lithgow Partnership and Hugh Harrison wish to thank the Dean and Chapter of Peterborough Cathedral and English Heritage for their enthusiasm and commitment to the conservation of the Nave Ceiling.

The work covered by this project is aided by a grant from the European Commission under the Raphael Programme.

As for Phase 1 we are grateful to the Project Team whose members have directed and advised on all aspects of the works; in particular, to Julian Limentani, Cathedral Architect to the Dean and Chapter. Gillian Lewis, Consultant Conservator to the Cathedral has given invaluable guidance and practical support throughout. The research carried out by Donald Mackreth, Cathedral Archaeologist, and Paul Binski, Art Historian, has contributed significantly to our understanding of the Ceiling structure and the painted scheme.

Dr Ioanna Kakoulli, deputising for Helen Howard, both of the Courtauld Institute of Art, Conservation of Wall paintings Department conducted the paint sample analysis for Phase 2. We required Ioanna to provide us with a great deal of information, building upon the previous exemplary work carried out by Helen Howard. Ioanna proved more than equal to the task and her detailed, immaculately presented report is an invaluable document and a testament to her dedication and hard work. Similarly, the two impressive reports presented by Cathy Groves of the Sheffield Dendrocronology Laboratory, University of Sheffield detailing her research and investigations to date have provided us with important information on the original ceiling structure and later additions. These scientific investigations as central to the project and we would like to thank both the Courtauld Institute of Art, Conservation of Wall paintings Department and the Sheffield Dendrocronology Laboratory, University of Sheffield for their continuing collaboration.

The graphic documentation for the technical survey is based on photogrammetric drawings of the underside of the Ceiling plotted by Photarc Ltd, images provided by the English Heritage Survey Team and a plan of the ceiling structure, upper side created by Bill Blake of English Heritage Survey Team using a Reflectorless EDM (Electromagnetic Distance Meter). The work carried out by Bill Blake and the ready support provided by Paul Bryan and the rest of his Survey Team has been crucial. We are immensely grateful for their co-operation.

List of Project Team members for Phase 2:

Julian Limentani, Don Mackreth, Gillian Lewis, David Goode, Adrian Heritage, David Heath, Ian Harper, Helen Howard, Ioanna Kakoulli, Paul Binski, Tobit Curteis, Paul Bryan, Sharon Cather, Catherine Groves, John Ward, Linda Monckton, the Perry Lithgow Partnership, Hugh Harrison.

WEST

0/I	0/II	0/III	0/IV
1/I	1/II	1/III	1/IV
2/I	2/II	2/III	2/IV
3/I	3/II	3/III	3/IV
4/I	4/II	4/III	4/IV
5/I	5 /II	5/III	5/IV
6/I	6/II	6/III	6/IV
7/I	7/II	7/III	7/IV
8/I	8/II	8/III	8/IV
9/I	9/II	9/III	9/IV
10/I	10/II	10/III	10/IV
11/I	11/II	11/III	11/IV
12/I	12/II	12/III	12/IV
13/I	13/II	13/III	13/IV
14/I	14/II	14/III	14/IV
15/I	15 /II	15/III	15/IV
16/I	16/II	16/III	16/IV
17/I	17/II	17/III	17/IV
18/I	18/II	18/III	18/IV
19/I	19/II	19/III	19/IV
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21/I	21/II	21/III	21/IV
22/I	22/II	22/III	22/IV
23/I	23/II	23/III	23/IV
24/I	24/II	24/III	24/IV
25/I	25 /II	25/III	25/IV
26/I	26/II	26/III	26/IV
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28/I	28/II	28/III	28/IV
29/I	29/II	29/III	29/IV
30/I	30/II	30/III	30/IV
31/I	31/II	31/III	31/IV
32/I	32/II	32/III	32/IV
33/I	33/II	33/III	33/IV
34/I	34/II	34/III	34/IV
35/I	35 /II	35/III	35/IV
36/I	36/II	36/III	36/IV
37/I	37/II	37/III	37/IV
38/I	38/II	38/III	38/IV
39/I	39/II	39/III	39/IV

NORTH

SOUTH

EAST

Figure 1. *Plan of the Nave Ceiling indicating Bays 2 and 3 and illustration of Bays 1, 2 and 3 before Phase 2 works*

PART 1: INTRODUCTION

1.1. SCOPE OF PHASE 2

To continue on from the recording and treatment works carried out in 1998 (Phase 1) to Bay 1 of the Nave Ceiling[1]. Phase 2 works were confined to Bays 2 and 3, Ceiling panels *(28-35 I/II/III/IV)*[2] north and south vertical Ashlar boards *(28-35)* and associated Ceiling structure.

1.2. OBJECTIVES

- To record the present condition of the ceiling.
- To record detailed analysis of the 18th and 19th century restorations.
- To investigate further the dating of the softwood boards.
- To investigate the underpaint of the original boards with the trefoil and chevron designs including the elaborate scrolls, and to determine how the raised areas were formed.
- To investigate the underpaint of the Ashlar boarding to date the boards and the paint.
- To investigate the underpaints to the grooved boards with the key pattern and to determine what the original design was and when it was changed.
- To analyse the efflorescence and determine its composition.
- To investigate and identify the microbiological growth on the ceiling boards and to determine what if any, damage they are causing.
- To conserve the structure, boards and decoration of the ceiling.
- To remove the grime from the painted surface.
- To leave the ceiling in a stable state and minimise the need for further interventions for a period of at least fifty years.
- To provide a recommended Schedule of Inspection and maintenance assuming a close inspection via hydraulic cradle can be used.

1.3. CONSERVATORS

Treatment of the Ceiling boards and Ceiling structure was carried out by Hugh Harrison - Rincombe Farm, West Anstey, South Molton, Devon EX36 3NZ - and his team: Bob Chappell, Cameron Stewart, Brett Wright, Peter Ferguson RIBA, Jonathan Porter, Claire Cully.

Richard Lithgow and Mark Perry of the Perry Lithgow Partnership, 1 Langston Lane, Station Road, Kingham, OXON OX7 6UW carried out treatment of the painted decoration. Assistant conservator - Peter Martindale, Louise Bradshaw, Caroline Baines, Cristina Beretta.

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[1] *Peterborough Cathedral: The Nave Ceiling, Phase 1: rows 36 – 40. Condition Survey and Conservation Treatment, January – June 1998, Vols. I, II & 3.* The Perry Lithgow Partnership and Hugh Harrison.

[2] These reference numbers refer to Nave Ceiling panels identified in **Figure 1.** Plan of the Nave Ceiling.

1.4. DOCUMENTATION

Richard Lithgow and Hugh Harrison have collaborated in compiling this document. All sections relating to the Ceiling structure have been written by Hugh Harrison; sections relating to the painted decoration by Richard Lithgow.

To ensure continuity throughout the phased programme of works to the Nave Ceiling the systems and formats devised for recording information gathered during Phase I for both the preliminary technical survey, subsequent testing and treatment were adopted for Phase 2 with only minor modifications. These changes to the systems, sanctioned by the Project Team, were made to reflect our improved knowledge of the materials, techniques and conservation history of the ceiling. This allowed more accurate definitions and descriptions of each aspect suggesting the need to record a number of additional categories of information. As with Phase 1 the principle objective has been to gather and record as much information as possible about the Ceiling structure and painted decoration. The emphasis has been on the collection rather than the display of information. An enormous amount of data is now available in written and graphic formats, not all of which is presented in this report. All such additional data has been submitted to the documentation co-ordinator for this project on hard copy or CD-ROM and shall be entered into the project database.

1.4.1. Graphic Record

A detailed graphic record has been made of the Ceiling structure upper side. The location of all elements of the structure and interventions made during this phase of treatment have been plotted onto photogrammetric plans of the Bays 2 and 3. Similar graphic records have been generated of the Ceiling structure lower side: these locate all visible fixings and previous alterations. For the condition survey of both the structure and the painted decoration categories of damage and deterioration have been plotted onto the photogrammetric plans: the individual panels and vertical Ashlar boards at either 10:1 or 15:1 scale). For the treatment record all interventions made during this phase have been similarly plotted and identified. All this information has been transferred onto overall plans of the Eastern Bay and has been reproduced at either 50:1 or 35:1 scale in Part 14 of this report.

As an aid to reference, the graphics for the lower side of the Ceiling have been plotted over photographic images of Bay 2 and 3, individual panels or Ashlar boards[3].

The graphic record has been digitised so that any combination of categories may be generated in any format on overall plans of Bays 2 and 3 or on plans of the individual panels. Parts 1 to 13 of this report - as well as graphics containing some 30 categories of damage and treatment - have been put onto CD-ROM. A copy of the disk, along with all source material associated with Phase 2, has been submitted to the documentation co-ordinator for this project.

1.4.2 Written Record

To compliment the graphic records many aspects of the construction and condition of the Ceiling boards have been recorded for each Ceiling panel. (see example in **Appendix 2**).

[3] Images taken from photographs used by English Heritage Survey Team as part of the photogrammetric survey.

Information relating to the structure includes: wood type, measurements and shape, joints, displacement, interventions, forms of insect damage and decay. Similarly a board by board condition survey of the paint has been drawn up (see examples in **Appendix 3**). This records the decoration on each board, visible underpaint, surface accretions and alterations to the paint surface as well as descriptions of damage and deterioration. These board by board surveys of the Ceiling structure and painted decoration have been recorded as tabulated data using the Microsoft Excel spreadsheet programme.[4]. In the future this will be transferred to the Microsoft Access project database set up by Tobit Curteis.

To ensure the documentation remains consistent throughout the project we have developed a glossary of categories, terms and definitions relating to all elements of the structure and condition of the Ceiling. This glossary is reproduced in **Appendix 4** of this report. Copies of the glossary and other statements defining the recording process were given to all members of the Perry Lithgow Partnership/Hugh Harrison Team. The team members communicate and collaborate throughout the recording process to ensure consistency.

1.4.2. Photographic Record

The photographic record includes identical sets of colour transparencies and prints. In an effort to keep the number of record photographs for this phase within manageable proportions the following strategy was adopted:

All areas were photographed from the scaffolding, both before and after treatment using moderately angled flashlight. The larger, horizontal panels *(II/III)* are covered by three photographs each, the canted panels *(I/II)* by two. The 4 full and 4 half-figurative lozenges included in Phase 1 were photographed as individual objects. Each figurative lozenge crosses over 4 panels.

Examples of deterioration and phenomena categorised in the graphic and written records have been photographed repeatedly in different lighting conditions before, during and after treatment. The area covered by each photograph and the lighting conditions employed are recorded on reference sheets (see example in **Appendix 5**). In addition, the Plate Reference Sheets in Volume II locate the area of the Ceiling covered by each Plate.

1.5. PARALLEL INVESTIGATIONS AND WORKS

The condition survey and treatment carried out during Phases 1 and 2 and recorded in this document is only a part of a comprehensive, ongoing investigation of the Nave Ceiling undertaken by the Project Team and others.

- Photogrammetric survey - English Heritage Survey Team and Photarc Ltd.
- Dendrocronology – Cathy Groves, Sheffield Dendrocronology Laboratory?
- Paint sample analysis - Helen Howard and Dr Ioanna Kakoulli, Conservation of Wall Paintings Department, Courtauld Institute of Art
- Analysis of nails – Dr Brian Gilmore
- Analysis of microbiological growth – Dr Brian Ridout, Brian Ridout Associate
- Environmental monitoring – Tobit Curteis, Tobit Curteis Associates

[4] In the future this will be transferred to the Microsoft Access project database set up by Tobit Curteis. The current version of Access will not allow accept more than 250 characters in each cell.

- Archaeological survey - Donald Mackreth, Cathedral Archaeologist
- Art historical research – Professor Paul Binski, Art Historian, Cambridge University

Aspects of these investigations and research are referred to in this document; although, the findings are to be presented as separate reports by the specialists concerned.

PART 2: DESCRIPTION OF THE NAVE CEILING

2.1. GENERAL

The wooden Nave Ceiling at Peterborough is an extremely important survival. There are three Ceilings of comparable age in Europe but all are smaller: St Martin's, Zillis in Switzerland (c. 1150); St Michael's, Hildesheim in Germany (c. 1200); Dädesjö, Smaland in Sweden (c. 1275). Binski[5] suggests: '*The painted wooden ceiling of Peterborough Abbey is the largest surviving example of its type from the Middle Ages, easily surpassing in scale those in Switzerland, Germany and Scandinavia to which it is sometimes compared. ..... It stands with a very few other 13th-century English instances of painted vault or ceiling decoration: the paintings of c. 1220 formerly on the vaults of the Trinity Chapel at Canterbury Cathedral; the overpainted mid 13th-century choir and presbytery vaults at Salisbury Cathedral; the late 13th-century wooden painted vaults of the presbytery at St Albans Abbey; the Chapterhouse vault at York Minster; and in the secular domain, the ceiling of the Painted Chamber in the Palace of Westminster* .'

Groves dendrochronological analysis indicates the oak boards were derived from imported timbers, probably from northern Germany, and are the earliest group of deliberately imported timbers analysed in Britain. They pre-date the period of extensive export of timber through the German Hanse, in the form of oak planking, from the eastern Baltic region, during the early-fourteenth century to around AD 1650, and are thus a valuable addition to the growing body of information concerning the evolution of the timber trade.

2.2. MEASUREMENTS

- Nave Ceiling: 204 ft (62.2 m) x 35 ft (10.7 m)
- Horizontal panels within rows (II/III): 11-ft (3.35 m) x 5 ft 3 ins (1.61 m).
- 45° canted panels in the outer rows (I/IV): 8 ft 5 ins (2.56 m) x 5 ft 3 ins (1.61 m).
- Central lozenges (boards within the key -pattern): 7 ft 7 ins (2.31 m) x 3 ft 9 ins (1.15 m).
- Outer canted lozenges: 5 ft 9 ins (1.76 m) x 3 ft 5 ins (1.05 m).
- The vertical Ashlar boards running the length of the Nave immediately beneath the Ceiling on the north and south walls: 19 ins (0.48 m) high .

[5] Paul Binski, Cambridge, 1999.

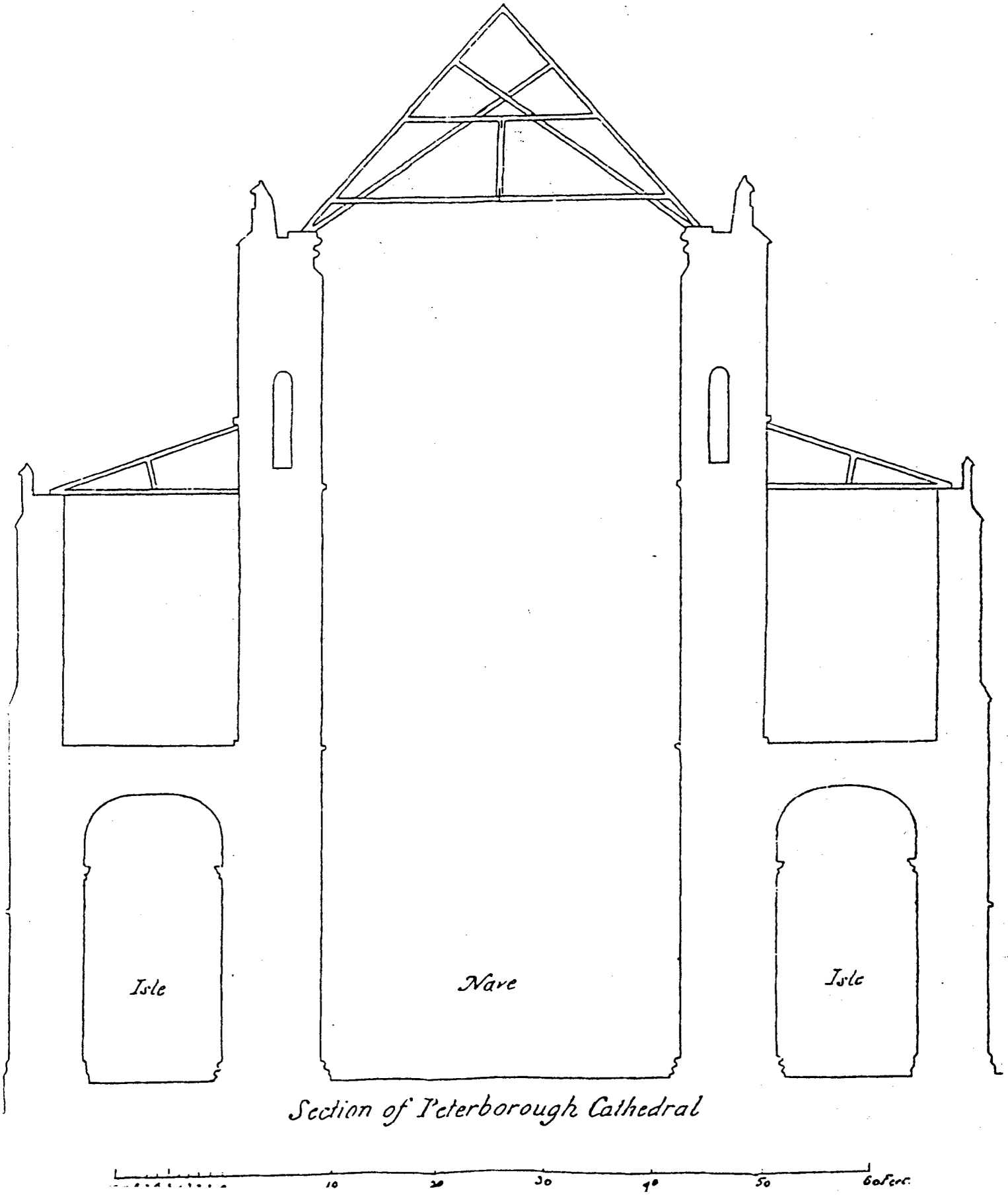

Figure 2. *Section of Peterborough Cathedral - Drawing by Samuel Ware, ca. 1805*

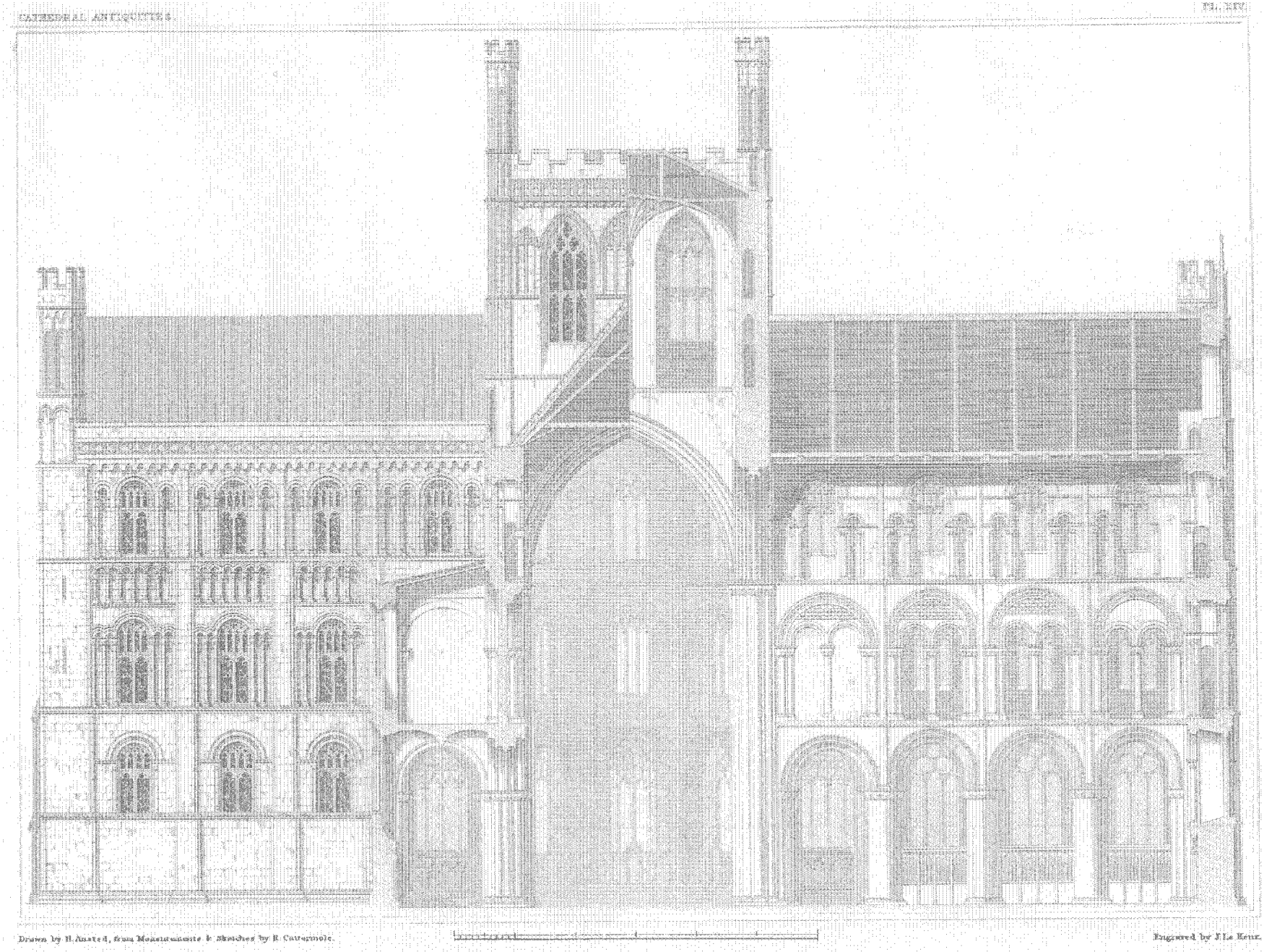

Figure 3. *Half section , half elevation of Transept, N to S looking East - Drawing by H. Ansted, ca. 1828*

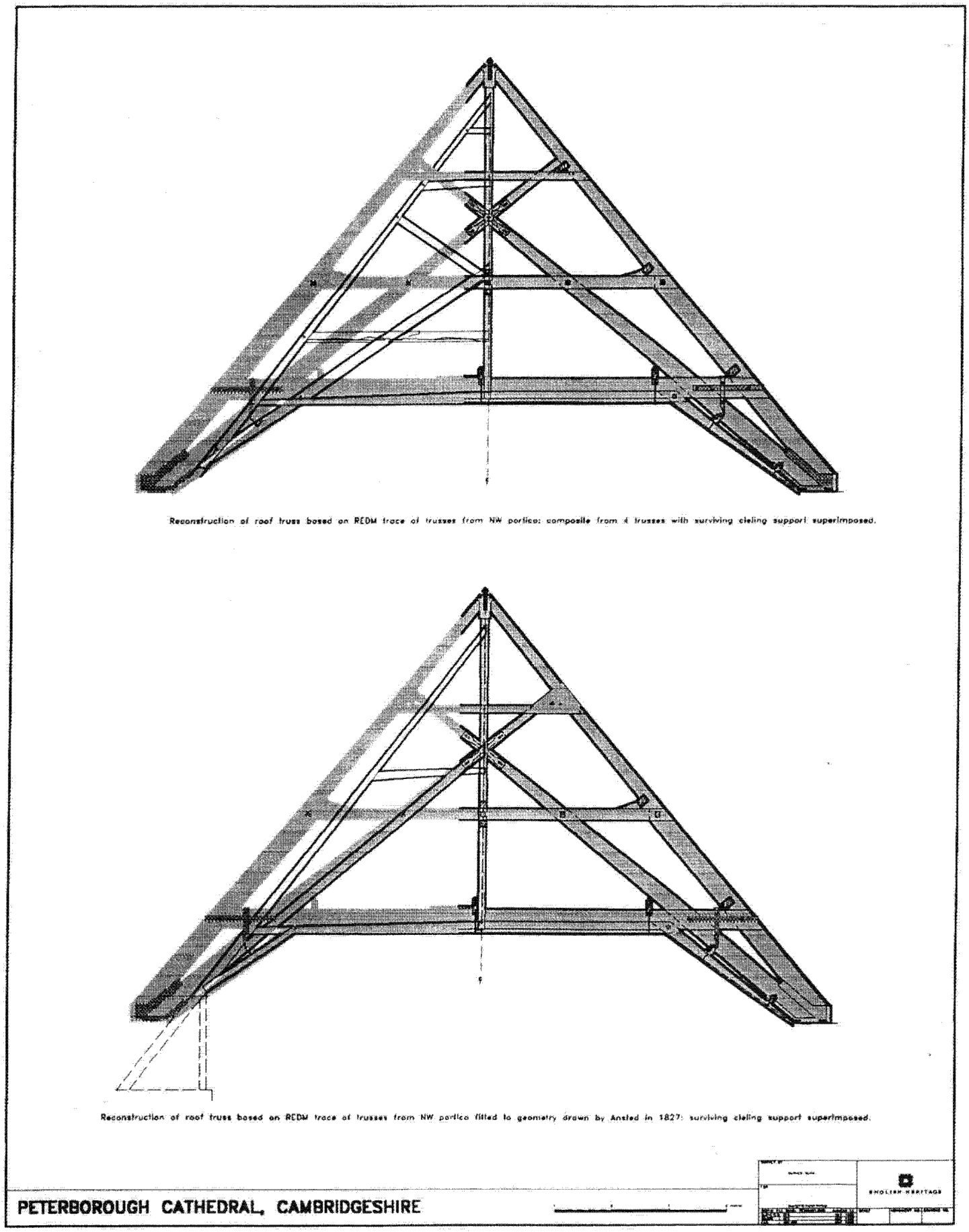

Figure 4. *Reconstruction of roof truss - Drawing by English Heritage Survey Team, 1999*

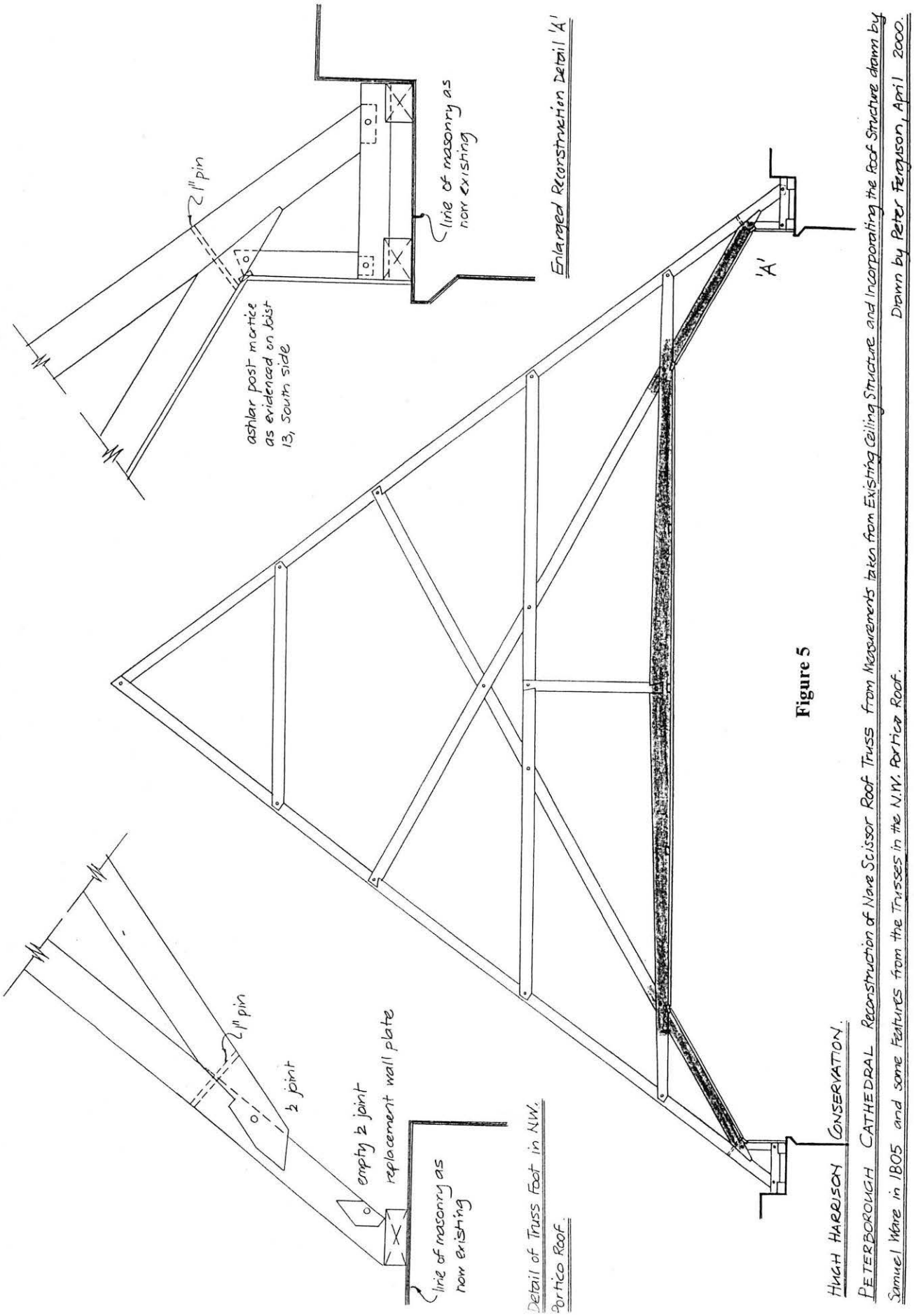
Enlarged Reconstruction Detail 'A'
line of masonry as now existing
ashlar post mortice as evidenced on joist 13, South side
1" pin
'A'
Detail of Truss foot in N.W. Portico Roof.
line of masonry as now existing
empty ½ joint
replacement wall plate
½ joint
1" pin
HUGH HARRISON CONSERVATION.
PETERBOROUGH CATHEDRAL Reconstruction of Nave Scissor Roof Truss from Measurements taken from Existing Ceiling Structure and Incorporating the Roof Structure drawn by Samuel Ware in 1805 and some Features from the Trusses in the N.W. Portico Roof.
Drawn by Peter Ferguson, April 2000.

Figure 5

2.3. ROOF STRUCTURE

2.3.1 Original Structure

None of the original roof survives other than as individual components reused in later reconstructions. Two drawings of the roof from the early 19th C. survive, one by Charles Ware in 1805 (see **Figure 2**), the other by H. Ansted which was published in Britten's *History and Antiquities of Peterborough Cathedral* in 1828 (see **Figure 3**). This latter was made from site drawings by R. Cattermole. It has been said that Ansted's drawings formed part of the survey drawings made for the Cathedral architect at the time, Edward Blore. Both drawings show what is basically a scissor brace roof, but Ansted shows the painted ceiling attached to separate lower sloping joists which are quite distinct from the scissor braces. Perhaps more interestingly, neither drawing shows the Ashlar boarding or any space for it. Of the two drawings, that by Ansted has the most inaccuracies compared with what still exists to day.

English Heritage has submitted two speculative reconstruction drawings based on the existing geometry of the surviving ceiling timbers and the geometry of the scissor brace roof in the north west portico (see **Figure 4**).

In consideration of both the documentary evidence[6], and the surviving original ceiling timbers[7], it seems very likely that the original roof was basically a scissor braced common rafter roof, rather than a truss and rafter roof (see **Figure 5**).

Throughout the section of the roof above the area of ceiling included in this Phase of works, a number of reused timbers were found and noted, presumably from the original roof. These were not studied or measured, but one as shown in **Plate 28** is seen to have a halving joint cut in it. It is strongly recommended that all the ancient reused timbers are measured, as they might provide more information which could help recreate the design of the original roof.

2.3.2 1830s Roof

The entire roof was restored by the architect Edward Blore in the 1834/5 The building firm and carpenters, Ruddles[8]. It seems from the drawings referred to above, that Blore's roof was similar in design to the original roof, though with the fundamental difference of his roof being a truss roof.

The roof from the central tower to the western vaulted bay consists of 26 main trusses and are spaced at 2600 mm-2900mm centres. There are five common rafters between each truss. These trusses are all bolted together using cast iron couplings and stiffeners. The feet of the trusses are contained in cast iron shoes which are bolted down to stone plinths built on top of the wall head (**Drawing 1**)[9]. The entire structure is made in softwood and the tie beam is a coupled beam with a beam placed on either side of the principle rafter and then bolted together.

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[6] *The Mediaeval Nave Roof and Ceiling of Peterborough Cathedral*. D Mackreth 1997

[7] *Tree-ring analysis of oak timbers from Peterborough Cathedral, Cambridgeshire: Structural timbers from the nave roof and north-west portico.* HBMCE, Ancient Monuments Laboratory, Report 9/99. I Tyers 1999

[8] D Mackreth 1997

[9] Drawing Nos. refer to explanatory drawings inserted at the end of Part 3 of this report.

As Blore stripped out the entire ancient roof, he had to find some way of suspending the painted ceiling He did this by running longitudinal binders on top of the coupled ties through which he suspended hanging bolts for each individual original joist. Between the first two trusses at the east end on both the north and the south sides of the roof, above the sloping sides to the ceiling, Blore inserted additional oak binders on top of the trusses. Similar hanging bolts to those used to suspend the flat part of the ceiling, were passed through these upper binders and down through the top end of the sloping joists. Only the binder on the south side now exists, but the bolt holes for the north bolts show that the same system once existed there as well. There is no evidence that the system was continued beyond this first truss. However, Leslie Moore, the Cathedral Architect in the 1920s reported in his initial survey of the Nave roofs[10] that the sloping joists were merely hung from the roof with assorted timbers of smaller dimension than the joists themselves, so it must be presumed that this is how these joists were supported west of the first bay.

2.3.3 1920s Restoration

Starting in 1924, the Cathedral's architect Leslie Moore carried out a major restoration of the roof which mostly involved re-slating, and inserting the low level roof lights etc.[11]. Moore further strengthened Blore's roof structure as can be seen by the cast iron plate on the lowest collar of the east truss recording its insertion in 1924. The extent of Moore's work within the roof has not been investigated to date, as this information has not been seen to be part of this project.

2.4. CEILING STRUCTURE

2.4.1 Original Structure Graphic 1

Upper side - The original oak ceiling structure consists of a series of cambered horizontal joists jointed at each end with a halving joint to a sloping joist. The sloping joists have bridal joints at their lower ends (or are these cut down mortices?) (**Drawings 2-4** and **Plate 31**) which were most likely jointed to Ashlar posts. No original Ashlar posts have been found to date to give any indication of the design of the original roof or ceiling structure at wall plate level.

Running between each set of joists are oak noggins, all as shown in the positions on **Drawing 5**. These are much smaller timbers, say on average 3" x 2" (75mm x 50mm) which are jointed with birds beak joints and fixed with nails to the underside of the joists.

Lower side – The ceiling is formed of riven boards placed clinker-fashion and nailed directly to the underside of the joists and noggins, with additional nails spaced along the edges of adjoining boards. The visible edge of each board is moulded with one of three different moulds and the sequence for these moulds remains constant with every lozenge. The centreboards in each lozenge, on which the figurative painting has been applied are also shaped slightly differently from the patterned boards.

[10] *Peterborough Cathedral – Report on the Strustural Condition of the Nave Roof and Ceiling*. L.T. Moore, ca. 1920.

[11] Moore's report is included as Appendix 2 of our Phase 1 Condition Survey and Conservation Record.

2.4.2 Interventions

2.4.2.1 14th C. Tower reconstruction - No positive evidence exists of any intervention at this time.

2.4.2.2 1740s / 1830s - The ceiling is the only substantive remains of the original mediaeval roof, which was renewed in the 1830s (see **Graphic 2**..

The extent of repairs from the 1740s restoration are at this stage unknown, but are not considered to be extensive, and possibly limited to replacing a small number of ceiling boards and possibly the Ashlar panelling.

It is presently thought that some patching to reinforce the ceiling boards was carried out in the 1830s together with the renewal of a small number of noggins alongside the substantial renewal of ceiling boards with softwood boards. It was at this time that the ceiling was suspended from hanging bolts.

It is also probable that the Ashlar panelling and the East Infill boarding were installed at this time. These are made with tongue and grooved softwood boards, and the Ashlar panels are nailed to the Ashlar posts. The top edge of each Ashlar panel is scribed to the profile of the overlapping boards of the main ceiling.

2.4.2.3 1880's Tower Reconstruction - A very small number of alterations/repairs have been found at the east end of the ceiling.

2.4.2.4 1920s Restoration - Almost all the 1830s repairs were stripped out and considerable reinforcement to the ceiling boards was added in the form of extra noggins. Some joists were renewed and patches added where whole areas of boards were weakened (see **Graphic 3**).

2.5. PAINTED DESIGN

2.5.1. Date

Binski suggests a likely date for the original painted decoration of not before about 1220 and not much later than about 1240. This is corroborated by the findings of paint sample analysis (Kakoulli and Howard) and tree-ring analysis (Groves).

There is documentary evidence that the painted scheme was restored between 1740 and 1750 and again in 1830s. There are no detailed records of these restorations; although, it clear that repainting on both occasions was extensive and inept. Investigations conducted in Phases 1 and 2 have established that the 1740s and 1830s restorers in the main followed closely the original foliate and figurative designs on the central boards of the lozenges, although the original lozenge border designs differ significantly from the present scheme. These differences and the results of all investigations and observations made during the Phase 2 technical survey of the painted decoration are detailed in Part 8 of this report.

Figure 6. *Illustration detailing the figurative subjects within the lozenges of Bays 2 and 3.*

2.5.2. Subject Matter

The painted design follows the arrangement of the Ceiling boards. It consists of three interlocking rows of diamond-shaped compartments, with a further row of half diamond-shaped compartments on the north and south sides. The inner boards of each compartment are decorated with a figurative subject. The subjects included in Bays 2 and 3 are listed in **Figure 6**.

Binski explains the Bay 2 and 3 iconography thus: *Next come the patron of the church, St Peter, and the Agnus Del hemmed in by a circle of demonic figures including much more obviously "negative" musicians. The triangular arrangement of the arts cedes, to a quadriform arrangement for the positive musicians, and finally a circular arrangement for the demonic forces, Last to the east come Janus, and a medallion with four lions circling a fish, of which more presently.*

The kernel of this end of the ceiling is obviously supplied by the Agnus Dei-Peter combination. The Agnus with chalice and cross-staff is one of the best-preserved images on the ceiling, its drawing tight, lithe and much in the spirit of the c. 1220 group of Peterborough Psalters. The image of the Lamb is inevitably widespread in this period. It occurs on a boss in the choir, crossing at Canterbury and in the choir at Durham, and towards 1290 it figured at the centre of the vault of the Chapterhouse at York in tandem with life-size profane and religious figures including Synagoga and Ecelesia with her chalice. In this sense it was not exclusively a choir image. What is of interest here is the way in which the patron and the Lamb are framed by images of vice, whose importance is such that they are promoted even to the ceiling's central spine. In a ring around Peter and the Lamb are the monkey riding backwards on a goat and holding an owl; Boethids' idiotic harp-playing Ass; a semi- naked fiddler; an anthropophagus; a pick-wielding demon, and a grotesque winged wyvern-like lizard or dragon. The Ass and Harp figure as a profane subject in Pictor in Carmine and, as is well known, the monkey-owl-goat motif occurs in the top frame of the Beatus page of the late 13th-century Peterborough Psalter in Brussels; it appears in other contexts to have had some popular connotations as well.

Towards the east, then, the ceiling confronts the moral extremes typical of the Psychomachia. We have already noted that the main west portal socle and tympanum volunteered a commentary of precisely this type, with Peter vanquishing Simon Magus, as he commonly does Nero. The nave ceiling affirms this spiritual triumph of Peter over perversity, insobriety and human or bestial appetite in general, and does so especially; by lending unique visual emphasis to those negative themes. The circle of hellish figures of course plays on several associations. The inclusion of a sinister ring-dance of demons, monsters, the Ass and Harp and the topless fiddler, links immediately to the Boethian triad of music and to the sphere of musica instrumentalls, i.e. pervertable sublunary music. This is presumably intended to counter the positive associations of the music mundana and musica caelestis of the Psalmodic instrumentalists with their trumpet, viol, organistrum and psaltery directly to the west, which ordinarily one might have expected directly to have prefaced the choir enclosure, and which were to provide such a fertile theme for church decoration within the diocese of Lincoln. We can at least say that the trump-blowing angel is one of the earliest musical angels in English art. And if some allusion to the moral life of monasticism enclosed from the all-embracing evils of the world is intended here, we might also catch in the last panel showing four confronted lions also circling a fish, an echo of the compline text 1 Peter "be sober, be vigilant, because your adversary the devil as a roaring lion walketh about (diabolus tamquam leo ruglens circuit) seeking whom he may devour".

Generally the 1740s and 1830s restorers followed closely the original foliate and figurative designs on the central boards of the lozenges (see **Plates 396, 398, 399**). The sole exception identified to date being the Dragon lozenge detailed in **Plate 397**. This

dragon has been found to be a 1740s invention. Underpaint visible in raking light indicates the original scheme had a Renard occupying only one quarter *(33 III)* of the lozenge. The shape of the Renard is outlined in **Figure 7**. Not enough low relief underpaint survives within the other three-quarters of this lozenge to suggest the original subject.

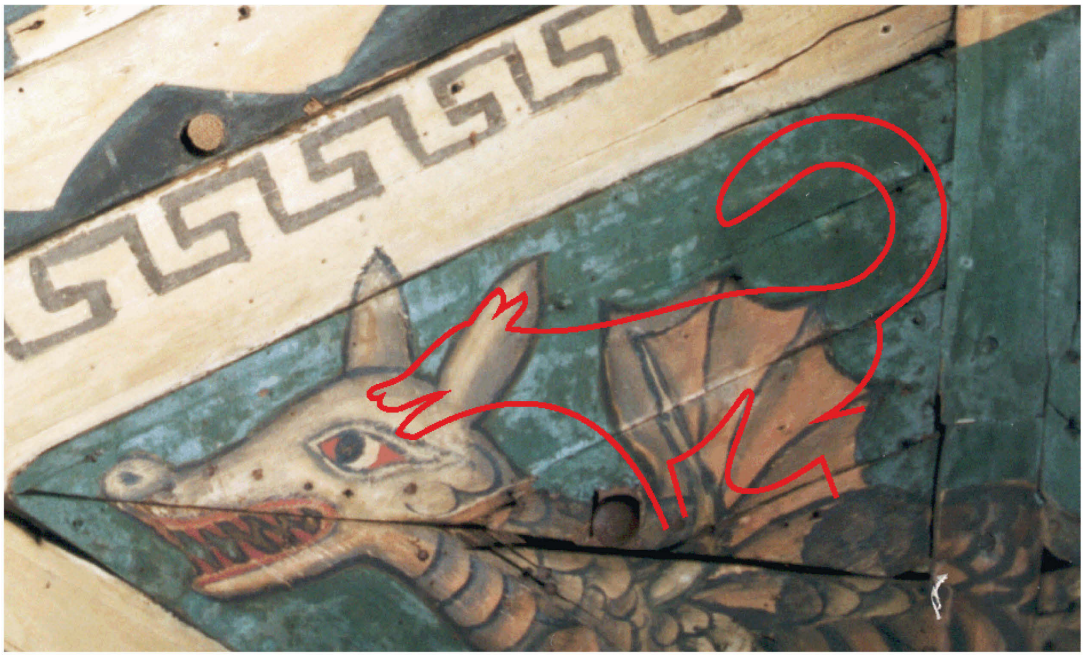
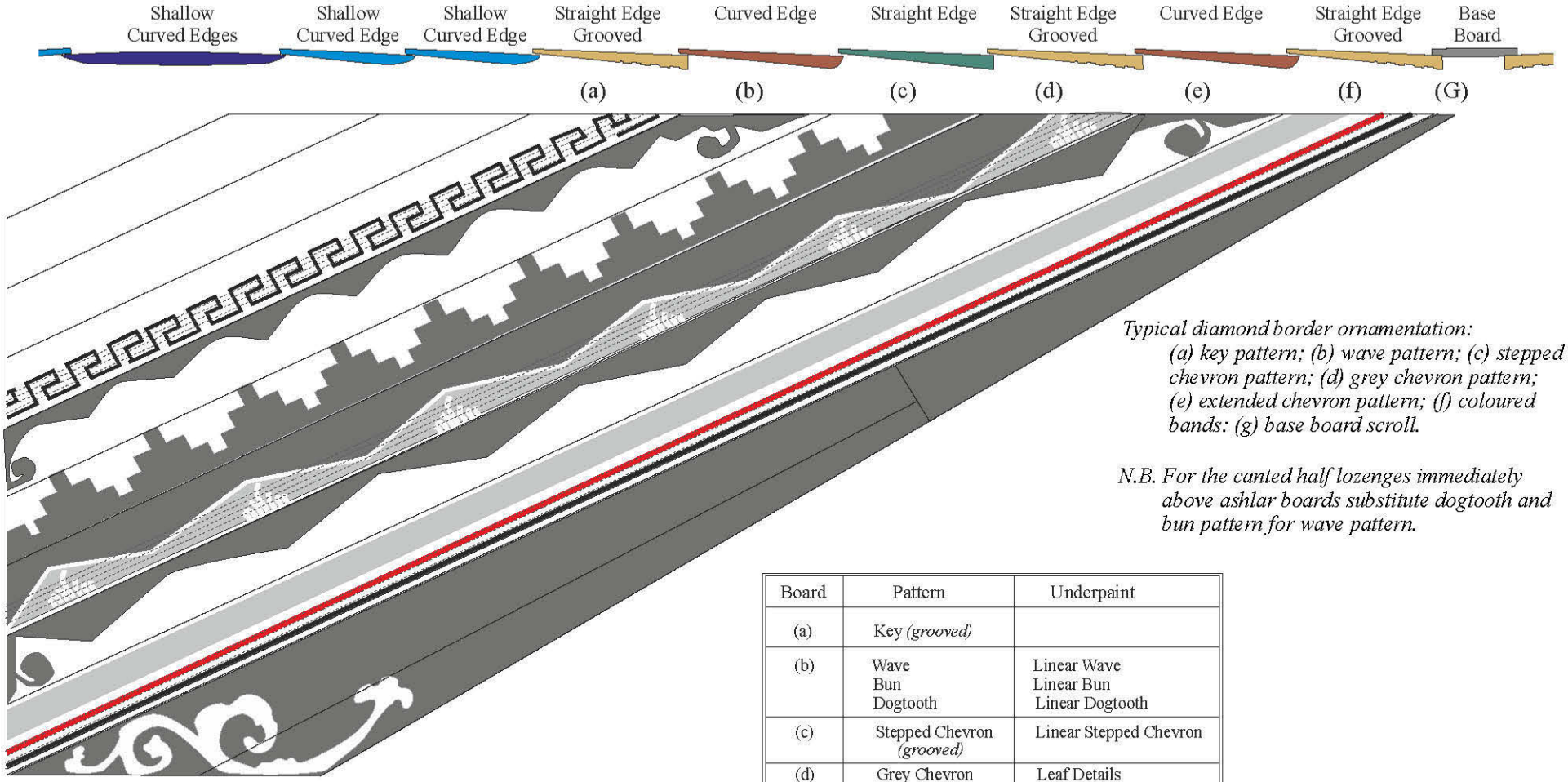


Figure 7. *Underpaint visible in raking light indicates the original scheme had a Renard occupying only one quarter (33 III) of the lozenge: here shown outlined in red. Not enough low relief underpaint survives within the other three-quarters of this lozenge to suggest the original subject.*

2.5.3. Decorative Designs

The figurative elements are small in scale relative to the surrounding decorative borders. The border ornamentation is similar for each diamond; although with occasional minor variations. The inner band a black key pattern on an off-white background. A black chevron or wave pattern with fleur-de-lis at the corners, also on an off-white ground. A crenellated or stepped chevron pattern, black on off-white. A grey, extended chevron pattern separated from the black background by a white line; the chevrons have white embellishments. An extended, black chevron or wave pattern with fleur-de-lis at the corners, all on an off-white ground. The outer design is of coloured bands, brown and off-white; the off-white band forming the background to a red and a black line. The base boards filling the spaces between the diamond-shaped compartments have a white scroll design with trefoil ornament on a black background. **Figure 8** illustrates the sequence and arrangement the lozenge border decoration and board sections.



Typical diamond border ornamentation: (a) key pattern; (b) wave pattern; (c) stepped chevron pattern; (d) grey chevron pattern; (e) extended chevron pattern; (f) coloured bands: (g) base board scroll.

N.B. For the canted half lozenges immediately above ashlar boards substitute dogtooth and bun pattern for wave pattern.

Board	Pattern	Underpaint
(a)	Key *(grooved)*	
(b)	Wave Bun Dogtooth	Linear Wave Linear Bun Linear Dogtooth
(c)	Stepped Chevron *(grooved)*	Linear Stepped Chevron
(d)	Grey Chevron	Leaf Details
(e)	Extended Chevron	Trefoil
(f)	Coloured Bands *(grooved)*	
(g)	Scroll	Scroll

Figure 8. *Diagram of a typical lozenge showing the sequence and arrangement of the different board sections.*

Variations within the border patterns include a modification of the key pattern on lozenge *35/36 I/II* resulting in a hammerhead design (see **Plate 350**). The white embellishments on the grey chevron border design vary considerable within Bay 1 and the east half of Bay 2 (*Rows 39-33)*. To this point in the Ceiling the embellishments date from the 1740s restoration: they were not overpainted in the 1830s (see Plates 174-201). From *Row 32* westwards the 1740s embellishment becomes more formalised as a small V shaped 'leaf' motif. It is also from this point on that the 1830s restorers overpainted the grey chevrons and replaced the V shaped 'leaf' motif with a graduated series of white brush strokes (see **Plate 429**).

The lozenge border decoration varies for the smaller, half-lozenges immediately over the Ashlar boards. These boards have keyhole and dog-tooth patterns - both in black on off-white - in place of the stepped chevron and wave patterns (see **Plates 323 - 337**).

2.5.4. Ashlar Boards

Running the length of the Nave over the top of the north and south walls is a decorative frieze pattern: a scrolling design of stylised tendrils - in black, red, green and off-white - with recognisable flowers depicted in every downward loop alternating with stylised 4 petal flowers. Apart from the rose, the flowers are difficult to identify, but look similar to common garden plants, such as the mallow, and cranesbill. Detailed examination of the Ashlar boards during the Phase 2 survey and paint sample analysis has confirmed that the boards and painted decoration date from the 1830s restoration. The painted designs on the north and south Ashlar boards of Bays 2 and 3 are depicted in **Figure 19** in Part 8 of this report.

PART 3: TECHNICAL SURVEY: THE CEILING STRUCTURE

All the drawings referred to below can be found at the end of this Part 3 (page 34).

3.1 PREAMBLE

The report for Phase 1 was written in the order as set out in the Specification. This artificially split the upper side of the ceiling structure from the lower side, and it also required splitting all the later intervention work into the same categories.

With the experience of two phases of work, it is obvious that particularly with the later interventions, the thinking behind the repairs was to fix reinforcing material above the ceiling to secure the boards below. To split the work into the two categories of "above the ceiling" and "below the ceiling" is therefore both false and confusing. This report splits the Technical Survey into periods of work, and within each period both the structure "above the ceiling" and the underside are included.

3.2 ORIGINAL CEILING STRUCTURE GRAPHIC 1

The original oak ceiling structure consists of a series of cambered horizontal joists jointed at each end with a halving joint to a sloping joist. The sloping joists have bridal joints at their lower ends (or are these cut off mortices?) (**Drawings 2-4** and **Plate 31**) which were most likely jointed to Ashlar posts. No original Ashlar posts have been found to give any indication of the design of the original roof or ceiling structure at wall plate level.

Running between each set of joists are oak noggins, all as shown in the positions on the **Drawing 5**. These are much smaller timbers, say on average 3" x 2" (75mm x 50mm) which are jointed with birds beak joints and fixed with nails to the underside of the joists. Two fixing nails were tested by Dr Brian Gilmour, The Archaeo-Metallurgy Group, Dept. of Materials, University of Oxford[12]. His findings were that the nails had consistent characteristics of ironwork of the early 13th C.

In this Phase, it was found that additional noggins have been inserted from the west side of joist 9, half way between the noggin in the centre of the ceiling and that at the junction of the flat ceiling and the sloping sides, see **Plate 26** for a noggin in position, and **Plate 27** where the birds beak joint is empty. These noggins continue to the west end of the ceiling and are described as panel noggins in this report. (**Drawing 5)** It is worth noting how variably the original oak boards are nailed to these noggins. Thus in 18 out of 29 noggins there are two or less nails or nail holes per noggin.

Examination and recording the lower ends of the sloping joists revealed interesting remains of joints. These are recorded in **Drawings 2-4** and **Plates 29-33**. Two features are revealed. One is the sloping of the top face of the joist with a hole for a wooden peg in the centre of the top face of the joist and perpendicular to it, the other is the mortice cut in the underside of the joist end. In the side of joist 13 (**Plates 30-32** and **Drawing 3)** there is also a hole for a peg through the cheeks of the mortice. These joints are nothing like the joints at the ends of the scissor braces in the NW Portico where they lap/dovetail to the side of the common rafter (**Figure 5**). However this drawing does show that a vertical post was once jointed to the foot of the common rafter, in a similar manner the joint at the bottom of the sloping joists in the nave roof would seem most likely to have located onto the top ends the Ashlar posts.

No new evidence has come to hand to explain the exact position of the present ceiling structure within the original roof structure, or whether it is an adaptation of that structure when the stone vault was discarded and the painted ceiling was inserted. The fact that the noggins which are an integral part of the painted ceiling, were all inserted from below, and are rather crude timbers compared with the finely wrought joists, might indicate that the ceiling is a later addition. However **Figure 5** which seems fairly plausible might indicate that the ceiling structure is part of the original roof structure and that the shape of the ceiling merely reflects the position of the lowest roof timbers. One aspect seems certain which is that the angle between the sloping sides and the flat ceiling panel have not changed, as the halving joints where the sloping ceiling joists and flat ceiling joists intersect, still fit exactly. If there had been a change in angle, these joints would no longer fit.

[12] *Nails from the wood panelled nave ceiling of Peterborough Cathedral*. Dr B. Gilmour 1999

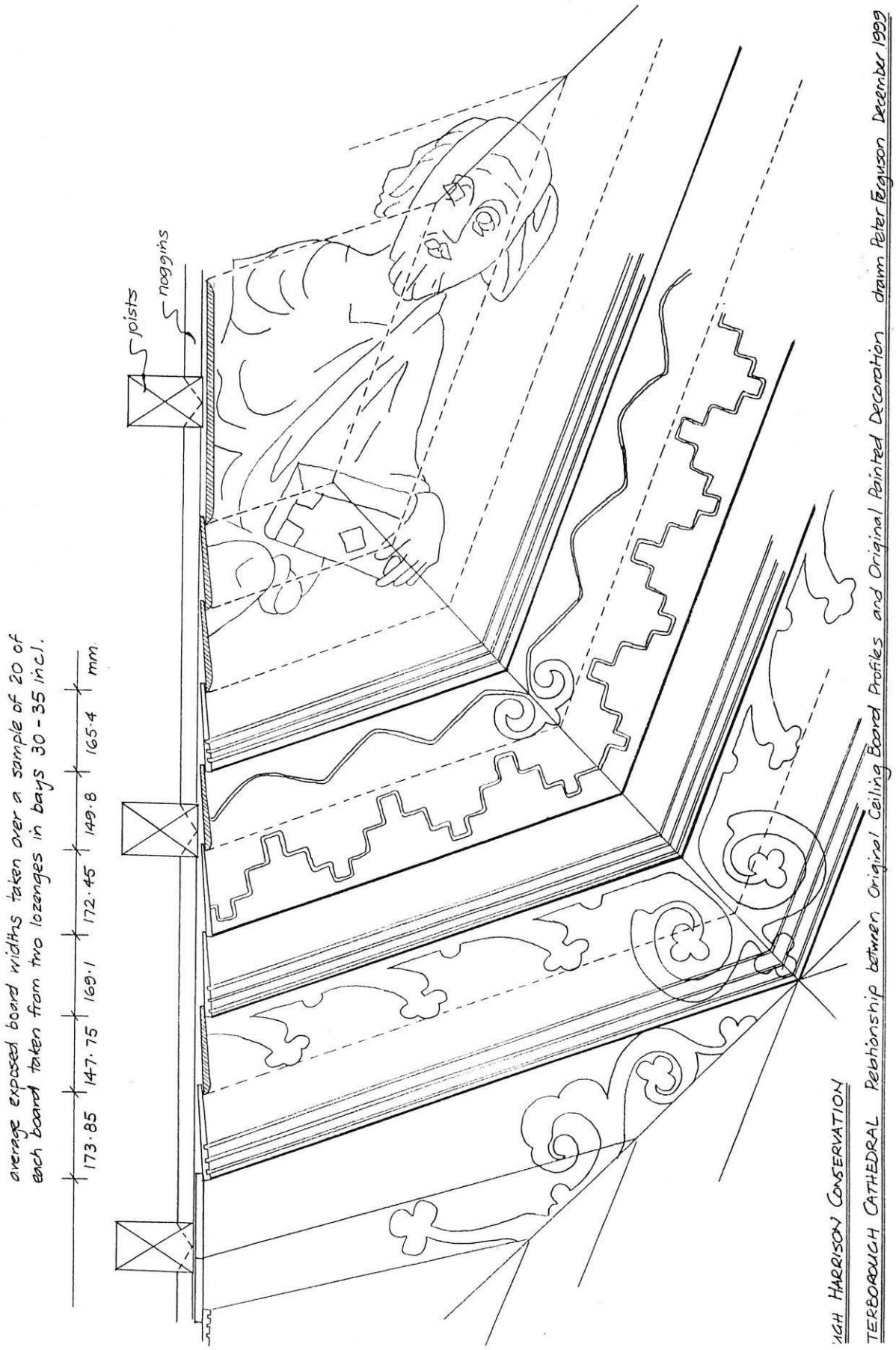

joists
noggins
average exposed board widths taken over a sample of 20 of each board taken from two lozenges in bays 30 - 35 incl.
173·85
147·75
169·1
172·45
149·8
165·4
mm
IGH HARRISON CONSERVATION
TERBOROUGH CATHEDRAL Relationship between Original Ceiling Board Profiles and Original Painted Decoration drawn Peter Ferguson December 1999

Figure 9.

3.2.1 Dendrochronology - Structure

Dendrochronology Samples from the joists were taken throughout the length of the roof by University of Sheffield, Dendrochronology Department[13].

The broad conclusion is that the ceiling joists indicate a construction date for the roof of AD 1180 – 1188, with some statistical evidence that Bays 1, 5, and 7 are slightly earlier. The report indicates that the trees are likely to have come from a single area of woodland in the eastern part of the country, likely to be somewhere in the vicinity of Peterborough. The trees are unusually slow grown and exceptionally long lived, the earliest recorded ring dating to AD 887.. A very few joists are likely to be from the same tree.

3.2.2 Boards – General

The underside of the Ceiling is entirely boarded and the area of ceiling covered in this Phase of work has two different categories of boarding. The ceiling boarding with the lozenge design that occurs on the flat part of the Ceiling and the two sloping sides, and the Ashlar boarding.

The ceiling boarding comprises the original oak boards and those replaced in softwood at various times. The Ashlar boarding is softwood tongue and groove boarding, probably 18th or 19th century in date.

3.2.2.1 Original Ceiling Boards - The original boards are riven or cleft oak and mostly have a tapered section. The boards are on average 200mm wide, and with a thickness of 15-22mm on one edge, and 3-9mm on the other. A maximum average length would be 2250mm with a very few boards up to 200mm longer. To acquire this tapered section (without conversion) the boards would have come from near the centre of a log of slim girth (probably less than 600mm in diameter), and would therefore have spanned the radius of the log from sap to pith. However dendrochronological examination revealed that "sapwood was once again noticeable for its absence" [14] so the log must have been just that larger to produce the boards clear of sap. To satisfy two factors that came to light following dendrochronological analysis in this Phase, those of good match of samples and two possible groups of felling date, Groves also speculates that the boards may have been produced from sufficiently large logs to have produced inner and outer boards.

The same moulds on the edges of the boards were found as in Phase 1, but in this Phase 20 examples of each of the six boards forming the decorative boarder to each of the central paintings in each lozenge was measured for sight width. Two boards in the sequence were noticeably narrower, that is both the round edged boards. Taking into consideration the flattening of the centre boards by rounding the edges so that the division in the boards would not distract from the picture painted on them, it is suggested that the round edged boards in the border are also not meant to read from the floor.
Figure 9 illustrates how the painted decoration might have read, and it is of particular note that the trefoil pattern develops into a finial at the corners where the pattern needs the two board width to express itself.

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[13] I Tyers 1999

[14] *Tree-Ring Analysis of Timbers from Peterborough Cathedral, Peterborough, Cambridgeshire: Boards from the Painted Nave Ceiling - Phase 2*. Cathy Groves March 2000

3.2.2.2 Upper Surface- As the top surface of the boards is hidden by the hessian, little information has been gleaned about it. Where small areas of hessian have been lifted, all that can be seen is a surface which has been worked to a good finish, but is not as smooth as the underside of the boards. The tool marks forming the finish have been indistinguishable to date.

3.2.2.3 Location Marks - In this Phase three instances of deliberate location marks were found (**Plates 36 – 38**), and one more informal (**Plate 39**). That in **Plate 38** clearly shows the use of scribes to mark the circle. Other than the baseboard in **Plate 36** there is no obvious reason for these to be location marks as this would imply fitting on a bench and re-assembly in the ceiling afterwards. As the position of each board is somewhat determined by the position of the existing boards in each lozenge sequence, it is hard to see how pre-fitting would work. As the baseboards are doweled together, this work would be carried out on a bench, but even then a locating mark would not help, as the relative position of the boards to each other is determined by the dowels, so whether the locating mark lines up after fitting the dowels is entirely dependent on the skill of the carpenter. Once the dowels are fitted there is no possibility of shifting the boards to line up the locating mark. The only other line of thought is that as all the marks are different, do they relate to a particular carpenter's work?

The scratch marks on **Plate 39** are an example of many other such marks which have been recorded and are shown on **Graphic 1**. As yet there seems no reason for them, however all further marks will be similarly recorded and analysed.

3.2.2.4 Baseboards - The baseboards are doweled together along their length, and in this Phase the joint between the base boards in *Panel 35 III* has opened sufficiently to measure the spacing between the dowels. These vary between 340mm (1'1 ½") and 390mm (1'3 ½"). See **Plate 34 and 35**.

3.2.2.5 Scarf Joints - Many of the boards are jointed in length and where this occurs scarf joints have been used. The length of the longest board, where a scarf joint has been used, was measured and recorded in the Board by Board Survey. The varied lengths of boards does not differ from Phase 1.

It is perhaps clearer in this Phase that in most instances the boards were cut so that the scarf joint came beneath an intermediate joist or panel noggin so that there was something solid to nail at least one of the boards to. No purposely placed original noggins were found above scarf joints as presumed last year in *Panel 39 III.*

3.2.3 Fixings

The original nails are those with round heads, approximately 18mm in diameter, and small square shanks, approximately 3mm square and 65mm in length (see **Plate 82**). Four nails were analysed by Gilmour whose his findings were that the nails are made of iron of bloomery origin entirely consistent of ironwork of the early 13th C.

The boards are nailed along their edges to each other, and at each end to a joist above, and to a panel noggin or intermediate joist for the boards in the flat part of the ceiling, all as was found in Phase 1. No new evidence was found of pre-drilled holes, though this possibility must remain a subject that should be further investigated. It is interesting to note the double nailing that can be seen in **Plate 41**, it must be assumed that the first nail did not catch the joist above, so a second one was driven. **Plate 42** shows a nail driven

too close to the edge of a board, so a part of the head overhangs the edge of the board. Someone actually took the trouble to clench over the segment overhanging so that the line of the board is not broken.

3.2.4 Dendrochronology - Boards

In view of the difficulties of springing boards, Groves experimented with a new technique for examining the tree rings without having to take samples of the wood itself [15]. Impressions were taken from the ends of the boards using FIMO moulding material which were then cast in resin and the annual ring sequences analysed from these casts. The results indicate a felling and using date after 1230, with the *t* values (indicating best match) being twice as high for North Germany (10.44) as to the highest match in England, that for the structural timbers in the Nave roof (5.68). Groves quotes Baillie and Pilcher 1973 "a *t* value of 3.5 or over is usually indicative of a good match" with provisos of other satisfactory comparisons. This importation of Baltic oak is substantially earlier than any other known importation, and will be subject to further investigation.

3.3 PREVIOUS INTERVENTIONS

It has already been recorded earlier in this Report that the roof was renewed in 1834/5, and restored again in 1924 and that it was at those times that the ceiling underwent major restoration. It has also been mentioned that the Tower was rebuilt in the 14th century and the 1880's.

In the 1740s the Ceiling was largely repainted and it is possible but not recorded that some structural work was carried out at that time. In the 1880s, the Tower was once again rebuilt, though the effects on the ceiling are hardly noticeable.
This section investigates evidence for these interventions.

3.3.1 14th Century

No hard evidence was found for any alterations to the ceiling when the tower was rebuilt at this time. One has to say that this is very surprising. There are empty birds beak joints on the east side of joist 1 indicating that there may have been additional noggins in this area. This might constitute evidence that the eastern infill panels were different before the tower was rebuilt.

No further evidence in this Phase of work has been found for alterations to the ceiling structure caused by rebuilding the tower at this date.

3.3.2 18th Century Graphic 2

It is recorded that the Ceiling was re-painted in 1740-1750, but there is no recognisable evidence in the Ceiling structure of any intervention at that date. Doubts were raised in the first Report regarding the dating of the replacement boards, and it had been hoped that dating of nails used in this period might have helped. Four lines of research have been pursued in this Phase: first, analysis of nails by Dr B. Gilmour; second, analysis of timber specie by Cathy Groves of Sheffield University; third, paint analysis by the Courtauld Institute; and fourth, paint layer identification by Richard Lithgow and his

[15] C Groves. March 2000

team. Their results are detailed later in this report. No positive conclusions have been arrived at yet, but all four avenues have yielded indications which hopefully with more information from future phases of work will yield positive results.

In view of the positive evidence that has become available in this Phase of work regarding the extent of the 1830s restoration, all discussion about the two possible programmes of structural repair (1740s and 1830s) will be assessed as 1830. It is recognised that some of this work may be reassessed as from the earlier programme.

3.3.3 1830s Graphic 2

Edward Blore largely renewed the Roof in 1834-1835 in imported deal. At that time Blore installed the wrought iron (as confirmed by The English Heritage Laboratory, April 1998[16]) hanging bolts to carry the flat part of the Ceiling, and the high level binders above the sloping joists only in the East Bay of the roof on both the north and south sides.
Further documentary comment on Blore's work can be found in Moore's report[17].

Little evidence has been found to date to definitely attribute any of the repairs to the ceiling structure to the 1830s other than two items. The first of these, is the two repairs that are attached to Blore's roof structure, (see **Plates 77 and 81**), where the use of the same nail type as seen in **Plates 46, 48, 50, 79, 80,** and **81** is found. The nail in **Plate 80** is in the underside of the ceiling, so it could not have been used by Moore (as he had no scaffold beneath the ceiling), yet as it also occurs fixed into Blore's work (**Plate 81**), it would seem that it can only be attributed to his period. The other item is the replaced joist (joist 20, north slope), which is of oak of a very different character to all other joists and has been inserted so that its bottom end rests on top of one of the 1830s stone plinths. This joist bears no comparison to the laminated composite joists inserted in the 1924/6 restoration. Other evidence is more circumstantial, and relates to a certain style of work, exactly described by Moore of Blore's work, as "rough and ready".

Graphic 2 illustrates the extent of the work to the Ceiling structure that this report attributes to Blore. It will be seen that it includes the replacement of joist 20 in *Panel 30 I*, the replacement of one major length of noggin at the ceiling angle in *Panels 31-29 III/IV,* further lengths of noggin at the base of the sloping joists, and two short joist doublers at the north and south ends of joist 11, and all the Ashlar posts.

3.3.3.1 Replacement Joist 20 in *Panel 30 I* - The joist is oak, and as it has a number of peg holes in it, it is quite possibly a re-used timber. Its upper connection to the flat joist is made with nails driven from the west side, see **Plate 62**.

The joist doublers at the north and south ends of joist 11 may be the last remnants of extensive similar work carried out by Blore as reported by Moore in his initial roof report, where he says first about the flat joists:

> *"This method of hanging the ceiling was adopted on the re-construction of the roof and at the same time some of the oak ceiling joists were repaired, but, owing to the difficulty of removing the decayed joists and attaching the ceiling to*

[16] Letter from D Heath to J Limentani, 24 April 1998
[17] Moore's report is included as Appendix 2 of our Phase 1 Condition Survey and Conservation Record.

> *new[18], the original diseased timber is merely secured to inserted strengthening timbers and in about six cases the added timber is now infected with decay from the older. In these instances both should be removed and replaced with new creosoted joists. ……..The oak joists(6" x 4 ¾") of the sloping sides of the ceiling are themselves in a fairly sound condition generally speaking……but at the present time they are merely hung from the roof and supported by short lengths of odd timber of a smaller section themselves.. this is most unsatisfactory especially as in by far the majority of cases the small timbers are in varying states of decay and are only nailed. This particular work is "rough and ready" workmanship (probably executed under difficulty with only light from lanterns) and the stability of the sloping ceiling joists cannot now be regarded as secure."*

3.3.3.2 Replaced Noggins - The long replacement noggin at the ceiling angle on the south side in Panels 31-29 coincides with an area of extraordinary butchery of the original joists. First, each joist (Nos. 18-22) has been cut back substantially on each side of the noggin, as have joists 11, 13, and 14 further east. It is almost certain that joists 15 and 16 were treated the same way, but these joints have been made good by Moore, so it is not certain whether he altered them before linking them. There seems at this time very little reason for cutting back these joints, in that if they were so badly decayed and consumed with death-watch beetle, why was the area so closely limited to the joint? Why is there no other decay that required cutting out in the rest of the ceiling (except north sloping joist 20)? How was the damage limited to so small an area in each case? Why only the joint?

Why is thought that this work is, 1830s not 1920s? The nails used in the repair of joist 17, which are also used to nail the intersecting ends of the flat and sloping joists to the tie beam to the east, show that this repair could not have been made before 1834/5 (as the tie beam would not have been there), and no nails anything like this have yet been found in Moore's repairs. All Moore's repairs used the laminated softwood system, and the long noggin is made of two pieces of rather rough oak, with none of the supporting laminated softwood found elsewhere in the 1920s work. The result of this work will have been to provide a series of timbers to which the ends of the ceiling boards could be secured, but there would still be a length of ceiling spanning 12 joists with possibly only 4 solid links between the flat and sloping ceiling joists. Moore has reported that these sloping joists were hung from the roof structure, so that must be accepted as one possibility, the other is the presence of dovetails cut in the sides of joists 13, 17, 18, 19, 20, and 22. One of these still has a nail in the dovetail, see **Plate 78**. Unfortunately this nail does not match the nails in **Plates 79 and 80** which have been positively identified as 1830s (see Item 3.2.2 above). So, are these dovetails coincidental to the substantial repairs in this area, or are they evidence of earlier repairs? It is recommended that the roof timbers above the dovetails are inspected in the next Phase to see if they have evidence of timbers fixed to them.[19] If there is nothing, it would seem that these dovetails are evidence of earlier repairs. If this is the case, thought should be given to analysing this nail to see if this provides any clue as to its date. [20]

All other noggins and patches are covered with hessian, so it is impossible to describe their connections with adjoining timbers.

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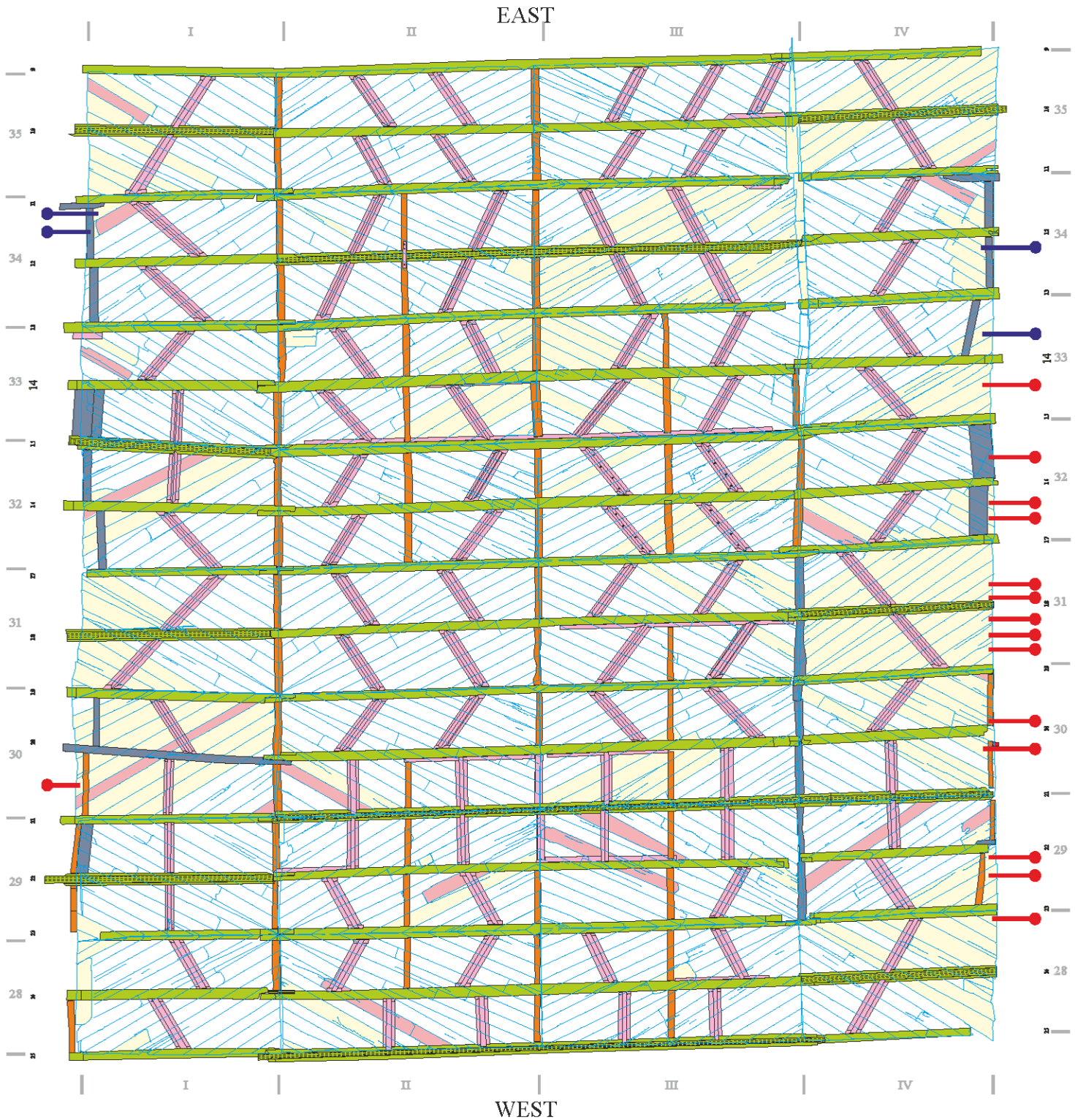
[18] Underlining by H Harrison

[19] Investigation for next phase - Check for nails in the roof timbers above the dovetails.

[20] Investigation for next phase - Ask Dr Brian Gilmour to test nail in dovetail..



● Type A (*Pinus sylvestris* group) ● Type B (*Picea/Larix* group)

Figure 10. *Plan from above showing Bays 2 and 3 and the location of sampled softwood boards.*

KEY

Edges of ceiling boards

Original joist
1926 composite joist

Added noggins

Original noggin

1830s reinforcements

Softwood replacement boards

Moved original boards

FIGURE No: 10

UPPER SIDE OF STRUCTURE

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels

SOUTH
WEST
EAST
NORTH

TITLE
PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE TECHNICAL SURVEY

DESCRIPTION

Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

The Perry Lithgow Partnership
1 Langston Lane, Station Rd, Kingham,
Oxon OX7 6UW Tel. 01608 658067

3.3.3.3 Replacement Boards - The number of replacement boards is significantly lower pro rata to the ceiling area in this phase than Phase 1 (see **Graphic 2)**. Like Phase 1 however, the number of replacement boards is much higher on the south side than the north. The different categories of replacement boards consist of the original boards repositioned (**Plate 89**) and **Plate 91** which is interesting, as this original board was previously fixed with an added dome headed nail (see the rectangular nail hole near the bottom of the scarf, so is it a board which was fixed twice in 1830, or was it first moved in 1740?), the softwood boards from the 1740s and 1830s, the 1740s Ashlar boards and one tongue and grooved Ashlar board presumably destined for the Ashlar panels but diverted to the ceiling (**Plate 90**). The characteristics of the softwood boards seem very similar to those found in Phase 1, with some having a very smooth surface, and some with a torn surface as though only roughly planed. No complete boards with the sawn surface were found.

Almost all the softwood boards were measured for thickness with the dimension inserted in millimetres in the column for "Torn Grain" in the Board by Board Survey Sheet. The thickness ranged from 10mm to 18.5mm with no apparent pattern or link between thickness and surface characteristics.

Groves analysed 19 samples of softwood from the ends of the sloping boards which overhang the Ashlar boards see **Plate 99**. The position of these boards is shown on **Figure 10**. Of the 19 samples, two genus types were identified, 15 samples being of the *Pinus sylvestris* group (Type A in her Report), and 4 samples being the *Picea/Larix* group (Type B in her Report). The four Type B samples were all found east of Joist 14 which also marks position where several other changes in painting/repainting technique are found and described later in this report in Item 8.3.2.4. It may or may not be coincidental that 3 of the Type B samples had a very similar thickness of 10mm or 10.5mm. The Type A varied over the full range of thickness from 10mm to 18.5mm.

A number of replacement boards have nail holes in them. At first sight this would seem to indicate that those particular boards are re-used boards, how else could boards fixed in the 1830s, and with no access to them from below ever since have lost some of their nails? A number of these holes can be explained as added nails extracted in the 1924/6 restoration where patches or noggins were inserted. But why would they need to be extracted? With the head of the nail tight to the top of the board, or the tail clenched over, there would be no need to take out the nails to fix a patch on top, especially with the laid clinker fashion the surface is completely uneven. In fact it would have been quite difficult to drive out the nails from above with no prop below to hold the boards firm as the nail is driven.

3.3.3.4 Ashlar Panelling - Perhaps the most complete aspect of Blore's intervention to the ceiling structure was the rebuilding of the Ashlar panelling. Evidence that this is Blore's work, rests on the nails (which have been identified as from his period of work) used to attach the ends of the sloping joists to the Ashlar posts (see **Plates 45, 48 and 50**). The other evidence is the disposition of the Ashlar posts with the stone pads for the main truss shoes. See **Drawing 6**.

Drawing 6 has an illustration in the centre of the sheet which shows the position of the Ashlar boarding in relation to the edge of the wall head cornice and the stone pads. This drawing was made to see if divergences of alignment between the panelling and the edge of the cornice were influenced by the position of the stone pads behind. The drawing,

which has a distorted scale to enhance the changes in alignment of the panelling, seems to show that any divergences have nothing to do with the stone pads.

The drawing also shows the variation in dimension and position of the pads and trusses in relation to the existing mediaeval timbers which are spaced very regularly. The asterisks on joists 13, 19, 22, and 25 on the north side, and 14, 22, and 25 on the south side show the butt joints between the sets of Ashlar boards. Whether there is any relevance that the boards always joint on a post in front of a stone pad is difficult to say. One possible answer maybe that the rough Ashlar posts between the stone pads are not fixed to the wall head at their bottom ends, so driving nails through the boards into the front of the posts could easily push them backwards, as the top of the posts are only lightly nailed to the sloping joists. Where the posts are against a stone plinth, they would be perfectly rigid to drive nails into.

There also does not seem to be a pattern to the length of each panel, although it may or may not be coincidental that the joint at the east end of this phase of work is nearly at the same point on the north and south walls (Joist 13 North, and 14 South), also at the west end of this phase, when it is at the same joist on both sides (25).

It may or may not also be coincidental that this is the point in the ceiling where several other repair techniques changed as discussed by Richard Lithgow in Item 8.3.2.5 of this report.

The Ashlar panelling consists of tongue and grooved boarding nailed to a medley of posts which are themselves nailed to the bottom ends of the sloping joists. Some of the posts are oak (see **Plates 45, and 48**), some are softwood (see **Plate 51**) see also **Drawing 6**. No recognisable pattern in the choice of oak or softwood can be seen, nor to the actual timbers used. These continue to be "rough and ready", Moore's description of Blore's work! The boards are of random width, ¾" thick and some exceedingly long, the section between joists 13 and 19 north side being 4700 mm (15' 5").

The Ashlar boards are nailed entirely with the dome headed nails on the north side and predominately on the south side.

3.3.3.5 Nails - Two styles of added nail (square headed and dome headed) have been identified (not including the large structural nails mentioned above), and are illustrated in **Figure 11.** These are the same two types as those found in Phase 1. See also **Plate 85** for a view of both types of nail head (and an original nail head), **Plate 83** for a view of a dome headed nail end above the ceiling, **Plate 84** for a view of both dome headed and square headed nail ends clenched over beneath the ceiling, and **Plate 86** for a view of a square headed nail end below the ceiling, where the head is now lying on top of the ceiling rather than on a patch which has since been discarded.

It had been hoped that different nail types would have distinguished different phases of work, i.e. 1740s or 1830s, so two nails of each type of added nail (square headed and dome headed) were sent for analysis by Gilmour. The results were inconclusive as to the date for the square headed nails other than that they had the characteristics of 18th C. production[21]. On the other hand, the dome headed nails showed signs of mass production and were assessed as early 19th C.

[21] Dr B Gilmour 1999

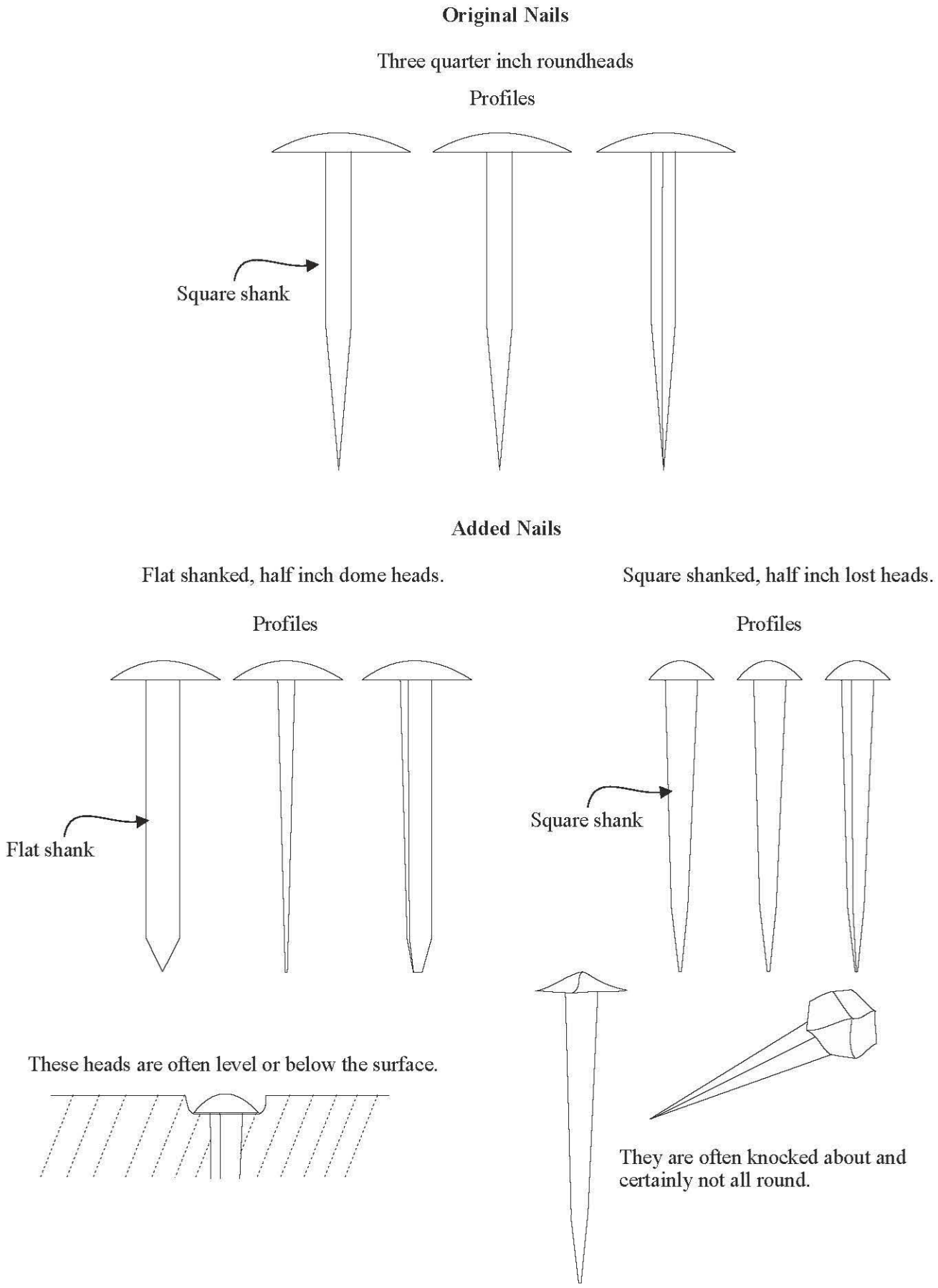


Figure 11. *Categories of nails identified in Bays 2 and 3.*

Although it would seem that little evidence exists of the 1830s repairs, study of **Graphic 2** appears to reveal patterns of nails which may be evidence of the extent of earlier repairs. It must obviously be recognised that as the nails have not been definitely dated, there remains the possibility that some of the nails and therefore repairs, might date from the 1740s.

A number of nail ends were investigated above the ceiling (see **Graphic 2**), these included square and dome headed nails, some with clenched ends against the ceiling boards, some with projecting ends. All those with projecting ends were found with the head of the nail resting on the top of the board, all those with clenched ends against the ceiling boards were found with no sign of the head of the nail above the ceiling boards.

3.3.3.5.1 Patterns of added nail use - **Graphic 2** shows both above and below the ceiling a predominance of square nails in Bay 2, a mixture of square and dome headed nails in the first Panel of Bay 3, then a marked predominance of dome headed nails in the remainder of Bay 3.

Graphic 2 shows groups of nails which could be defined by a patch one or two boards wide above the ceiling. These groupings are purely speculative but certain lines of added nails are not, such as the square nails in *Panel 32 I* West, the dome and square nails in *Panel 31 III* West, or the dome nails in *Panel 28 III* East.

When identifying the groups of nails, it is extremely difficult to create groups of nails running along the same line as the boards, they all seem to fall diagonally opposite the line of the boards, or straight across between the joists. This pattern of reinforcement is copied in the 1924/6 repairs.

It is curious that some lines of nails are found driven from below the ceiling. As the carpenter working below the ceiling would not know where the patch was above the ceiling into which he was driving his nails, it is possible that these are all nails fixing edges of boards together, and it is merely coincidental that the nails have been inserted in a straight line across a number of boards (see for instance Dome headed nails driven from below in *Panels 34 I and IV*, and *Panels 33 I and IV*). These are all instances where care needs to be taken in drawing conclusions that nails in straight lines are always associated with patches above the ceiling.

It should be noted that the great majority of the Ashlar boards are fixed with dome headed nails.

It had been hoped that two areas of replacement boarding fixed over the hanging bolts in Panel 34 III would provide valuable evidence of the nail type used in the 1830 restoration. Unfortunately both patches of replacement boarding are fixed with both types of added nail, so no help from this quarter.

3.3.3.6 Patches - The patch found in Phase 1 in *Panel 37 III* can be almost certainly attributed to Blore's work in 1834/5. No similar patches were found in this Phase of work, but there are many lines of nail ends below the ceiling which are arranged as though they once came through a patch above. A number of these nails were investigated above the ceiling by locating the heads below the hessian (see **Graphic 2**). In every case no nail head existed. As no patches were found in line with the nails, it can only be assumed that these patches were taken out in the 1920s. Evidence that the patches existed can be found in Moore's initial survey where he states "Many stiffeners to the boarding have

been added from time to time in a haphazard manner and repairs executed in places". All surviving patches from this period are shown on **Graphic 2**

In some cases, it seems that when the patch was taken out, the nails stayed intact and dropped down, so that the head which used to be on top of the patch now lies on top of the ceiling board. These are the projecting nail ends which emerge vertically from the ceiling and then bend at right angles where they used to be clenched over tight beneath the ceiling boards (see **Plate 86)**. In other cases, the tops of the nails must have been deliberately broken off and discarded.

It would have been necessary to strip out the old patches to enable the new patches to be inserted in the 1920s. There is no clue as to how the 1830s patches were taken out with all the nails still in place, other than by splitting out the old timber patches. (Unless of course, that the old patches were so worm eaten that the timber crumbled as it was removed.) If the 1830s patches were fitted neatly between the joists, it would have been very difficult to split out the timber as there would have been no access to the ends of the boards.

3.3.3.7 Hanging Bolts - The hanging bolts continue in this Phase as in Phase 1. In this Phase some were seen to have foundry marks on the shanks of the bolts and the washers.[22] (see **Plates 94-96).**

3.3.3.8 Further Documentary Research - It is to be regretted that all the recording and all the analysis of all the information of all aspects of this restoration has really only thrown up more questions. It is recommended that some effort is made to find out more documentary information on this phase of work either through Ansted who made the survey drawings, or Ruddles the builders, or Samuel Ware who made the drawing dated ca 1805.[23]

3.3.4 1880s

The Tower was completely dismantled by Pearson and rebuilt. There is no obvious evidence of any intervention to the ceiling structure from this operation, perhaps surprisingly. However in Panels 33 I, II, and III areas of boarding have been screwed into position from below. All these groups of screws are on the line of the screen apparently erected at the west end of the scaffold erected to carry out the rebuilding of the tower. The boards cut out to form the patches are characterised by being much dirtier than the surrounding boards and required considerably more effort to clean to the same level as the adjoining boards. See **Plates 210, 211, 206, 207** and **216, 217.** There is no obvious reason for these holes to be cut in the ceiling other than to allow the screen posts to be fixed to the ceiling joists above the ceiling. However, study of the timbers above does not appear to reveal any substantial holes or cuts to indicate any earlier fixings or attachments.

3.3.5 1924 Graphic 3

Moore made substantial alterations to the Ceiling structure. He stripped out all of Blore's "rough and ready" wooden hangers to the top end of the sloping joists and

[22] In Phase 3, record depressions in areas of boards which appear to have been deformed by over tightening of the hanging bolts; also where hanging bolts are loose.
[23] Further investigation in Phase 3

presumably he also took out Blore's hanging bolts to the sloping joists on the north side (although this could have been done by Pearson in the 1880s). He then inserted his own system of support to the sloping joists and reinstated some rigid connections between the sloping joists and the flat ceiling joists where these had been cut away in the 1830s (or less likely 1740s). Moore also stripped out all Blore's "inserted strengthening timbers" attached to the original "diseased" timbers and renewed some of the main ceiling joists and some of the sloping joists with laminated joists and inserted a complete new system of noggins to support the ceiling boards. In addition to the noggins, he also put in random patches to support what were presumably localised areas of weakness in the ceiling boards. He then reinforced the original noggins with laminated structures and had the whole roof treated with Silvertown Solution, an insecticide containing sulphur chloride and carbon bisulphide[24]. Lastly, he covered the whole ceiling, except his noggins and the original and his composite replacement joists, with hessian adhered with a water soluble animal glue.

Moore's work provides one of the main continuing questions, which is how did he renew so many joists without a scaffold beneath the ceiling? A system of support would have been necessary to hold a whole panel of ceiling boards once the original joist had been removed and before the new joist had been installed. It may be worth noting here that whilst the boards were in "transition", the hessian was applied as it runs beneath these composite joists.

Another valid question is <u>why</u> he replaced so many joists? Moore himself wrote in his initial survey, that he considered that Blore only added stiffeners to the sides of decayed joists because of the difficulties of replacing them, see 3.2.3.1 above. He then does exactly this and adding three times the difficulty, he does it with no scaffold beneath. Like the apparent lack of reason for cutting out the halving joints on many of the south joists, why were the joists replaced when there is no apparent sign of decay or infestation adjacent to the composite joists? It would be extremely unlikely to encounter such severe decay and infestation in a joist that it needed replacing to also find no hint of the same problems in woodwork fixed to it. If there had been a leak in the roof, it could not have only dripped on the joist; if Blore's inserted stiffeners were actively infested, it is inconceivable that the infestation transferred to the original joist and not into the boards beneath. It is also highly unlikely that there was any continuing infestation in the old timbers (unless they had got wet and were attacked by fungal decay), which transferred to the new (Blore's) timbers, and it is equally unlikely that infestation in Blore's stiffeners (which is quite likely) would have transferred to the ancient timbers unless they were actively decaying. Moore frequently mentions the "fair state" of Blore's roof timbers, and that there seemed little wrong with them except some sap edges, and detaching torching. He actually says "Wet does not appear to penetrate the covering to any extent", so the likely hood of numerous patches of wet rot and decay seem difficult to comprehend.

The most likely answer probably reflects the old adage about pruning roses "If in doubt, cut it out".

3.3.5.1 Sloping ceiling binders - Softwood binders were inserted near the top and bottom ends of the sloping joists. The top binders were carried either on steel hangers (**Plate 58**), or wooden cleats fixed to the side of the principle rafters (**Plates 53, 56, 60, 100**) The lower binder was supported on wooden cleats fixed immediately above the projecting flange of

[24] Spons Workshop Receipts, 5th Series, 1885.

the cast iron shoe made for the feet of the scissor braces (**Plate 43**). Galvanised coach screws (265mm x 18mm) were inserted where each binder passed over the joist beneath. This system is perfectly satisfactory so long as the sloping joists remain in good condition, but should they ever decay, the system would fail.

3.3.5.2 Joist Connections - There seems to have been an inconsistent policy of creating rigid connections between the sloping and flat ceiling joists where these had been cut back. In some instances, such as at the north connection Joist 9 (see **Plate 53**) and the south connection joist 15 (see **Plate 70**), the joints were reinstated using a laminated softwood system. However on the south side there are no connections for joists 11, 13, 19, 20, and 22. Thus the whole of the north side has flat and sloping ceiling joists with rigid connections, yet on the south side there are two areas where the majority of the weight is taken by the sloping ceiling joist top binders.

3.3.5.3 Composite Ceiling Joists – Moore renewed 11 individual joists (see **Graphic 3**) using a laminated construction matching the work in Phase 1. **Plate 105** shows an interesting situation where in *Panel 34 II* the original noggins were retained and connected to each other across composite joist 12 with galvanised iron straps. See also **Drawing 7**.

3.3.5.4 Noggins - A whole series of noggins were inserted of two basic designs but now recorded as six variations. These are detailed on **Drawing 8**, **Graphic 3**, and **Plates 101-105**. On **Graphic 3** each noggin is numbered to denote it's specific design. All the noggins and laminated joists continue to be made in half inch impregnated softwood boards screwed and nailed together and down into the ceiling.

It is thought that one of the reasons for using the thin laminated wood for all these repairs is that wood of this thickness could be fully impregnated with insecticide/wood preservative. It can be seen from Moore's report that this concern was a high priority, particularly in view of the infestation he found in the new timbers inserted by Blore.

3.3.5.5 Patches – In addition to reinforcement to original noggins, patches using the 150mm (6") by 12mm (1/2") impregnated softwood used for all other lamination etc. in the 1924/6 repairs, were applied one board thick on top of the ceiling boards. These patches ranged from 1 or 2 boards wide to 15 boards wide. The boards are laid at right angles to the joists (unlike Phase 1 where the only extensive patch in *Panel 37 I* was laid at approx. 45° to the joists) and fixed with large numbers of screws. These patches can be seen on **Graphic 3** and it is presumed that some replace the 1830s patches mentioned by Moore, see Item 3.3.3.6 above.

3.3.5.6 Patches in the ceiling - **Plates 204, 210, and 288** all show unpainted wooden patches. Plates 204 and 210 are within the area of the scaffold erected to rebuilt the Tower in the 1880's, and the patches shown in these plates could have been inserted at that time. However on the evidence of the care that was taken in the 1880's tower rebuilding to replace fragments of painted boarding cut out for whatever reason, it is unlikely that these crude unpainted patches would have been fitted at that time. If one adds that in two cases (**Plates 204 and 288**), the timber used for the patches matches the impregnated wood used throughout the 1924/6 repairs, it seems more likely that these patches date from this later restoration. It should also be noted that the patch in **Plate 210** is beneath a `1924/6 softwood patch. It is speculated therefore that these patches in the ceiling were screwed to boards inserted in 1924/6 restoration.

It should be noted however that the patch in **Plate 204** comes directly beneath a joist, which would make it almost impossible to replace from above, but as that joist is a laminated 1924/6 joist, the patch could have been screwed to the bottom laminate of the joist before it was fully constructed.

3.3.5.7 Original Noggin Reinforcements - In addition to the laminated noggins, Moore incorporated laminated reinforcements adjacent to, (or possibly sometimes replacing) original noggins. These are detailed on **Graphic 3** which illustrates additional types of reinforcement found to those used in Phase 1. This graphic details a system of notation which describes whether the reinforcement is one, two, or three boards thick, and whether the top board spans across the top of an original noggin. It is hoped that this notation can be used for the rest of the ceiling. The laminates are all fixed with screws as in Phase 1.

3.3.5.8 Screws - Screws were generally used to fix the laminates to the ceiling boards and to each other. Those taken out in Phase 2 were found to be the same size and type as in Phase 1. See **Drawing 5**, Phase 1 Report. Nails have also been used (as in Phase 1) as can be seen in **Plate 101** (*Panel 34 II*), and **Plate 102** (*Panel 34 II*). None of the 1924/6 nails have penetrated through to the underside of the ceiling.

It is interesting to see in **Plate 106** that screws were inserted after the hessian had been applied, and that they very much follow the edges of the boards beneath. What the criteria was for adding screws, that they were found to be necessary after the hessian had been applied is difficult to comprehend.

3.3.5.9 Timber Treatment - Moore recorded that he had already used Silvertown Solution to treat the North Transept Roof, and in his report he specifies its use on the Nave roof.

3.3.5.10 Hessian - On completion of all the patching and reinforcing work, Moore had the whole upper surface of the Ceiling covered in hessian adhered with animal glue. A sample of the hessian was sent to Dr DM Catling, Department of Biological Sciences, University of Durham[25] who analysed the fibres and confirmed that they are jute which is a species of *corchorus* (see **Appendix 10**). Significant additional patching to the hessian was noticed and recorded with another layer of hessian and strips of canvas. A piece of the canvas was also analysed by Dr DM Catling and confirmed as cotton, a species of *gossipium*. Strips of additional hessian have frequently been applied where the hessian runs up the sides of joists, and in two cases beneath composite joists. The canvas strips are also concentrated in certain panels where almost every joint is reinforced with additional strips. See **Graphic 3** and **Plate 114.**

The hessian has been applied in two layers. The first layer is comprised of strips approximately 50mm wide which are applied roughly perpendicular to the boards at approximately 200mm centres. A second overall layer has then been laid over the whole surface and is taken approximately 25mm up the sides of the joists.

Graphic 3 shows many seemingly random patches of hessian, and permission was given to carefully lift one patch to see if any evidence existed below the patch for why it had been applied. A patch was selected in *Panel 32 III* and **Plates 112/113** show the patch in place and after it had been taken off. There is no obvious damage that would warrant an extra patch being applied, though there would seem to be a tiny cut in the hessian in the

[25] Dr D M Catling. Unpublished letter to H Harrison, 16 October 1999

upper left hand corner of the patch (as seen in the Plate in the Photographic Survey Volume). Just above the cut, the hessian appears darker as though the patch never adhered in this area, and above this there is a darker patch as though a dark liquid is splashed on the surface. Around the added patch there is an irregular dark stain which might be the glue applied to the hessian to stick the patch with see also **Plate 142**. The size of the cut in the under layer of hessian does not seem sufficient to warrant the patch on top. If that is what the patch is there for, it seems unnecessarily large and badly positioned. Further investigation of such hessian patches and strips of canvas is required[26].

Perhaps a clue for the added strips and patches can be seen in **Plates 141/142**. In these plates the hessian has clearly split above joins in the boards below. Both areas shown in these plates are added patches where the boards are level with one another. Shrinkage of the boards after fixing, or shrinkage of the hessian after application can only occur where there is a joint below. In the roof as a whole, the hessian spans over the spaces where the boards are laid clinker fashion, so there would be regular gaps where the hessian is unattached where it can absorb either the contraction of the hessian or shrinkage of the timber.

A small length of canvas was carefully lifted and no sign of any damage to the hessian below was found. Also in the two bays where there are the most canvas strips (Panels 33/32 I and 29/28 IV) there are no softwood patches, so there is as yet no clue as to why these strips were applied.

There are two other anomalies with the hessian, both are evident in **Plate 111**. One query is that there seems to be at least three layers of hessian and the second is that the layer immediately below the top layer is black. Is this dirty hessian or dirty glue? As the normal sequence of narrow strips of hessian applied to the back of the boards, followed by the main layer does not seem to occur, it should be noted that where the slither of board had been inserted to fill the gap between two boards (see **Plates 107-110**) there were four layers of hessian. These were tested by Dr WD Cooke, Department of Textiles, UMIST for pH. as he had expected that the hessian would become more acid with age. It had therefore been hoped to find out if any of the layers were older than the others. No variation in pH. was found between the four layers. [27].

It should also be noted that **Plate 12** indicates different colours and possibly thickness of hessian between the noggins. These anomalies were not investigated in depth, and have been shown as the standard system, however with the evidence for multi layers of hessian found elsewhere, perhaps any apparent discrepancies found in the next Phase should be more thoroughly investigated.[28].

Three samples of the glue were analysed by Ioanna Kakoulli, of the Courtauld Institute of Art, Conservation of Wall Paintings Department, using FTIR and have been confirmed as proteinaceous glue[29]. It is recommended that more thorough research should be carried out into the nature of this glue in the next Phase of work[30]. At the team Meeting No 9 on the 7th December 1999 a suggestion was made that the Metropolitan Police Forensic

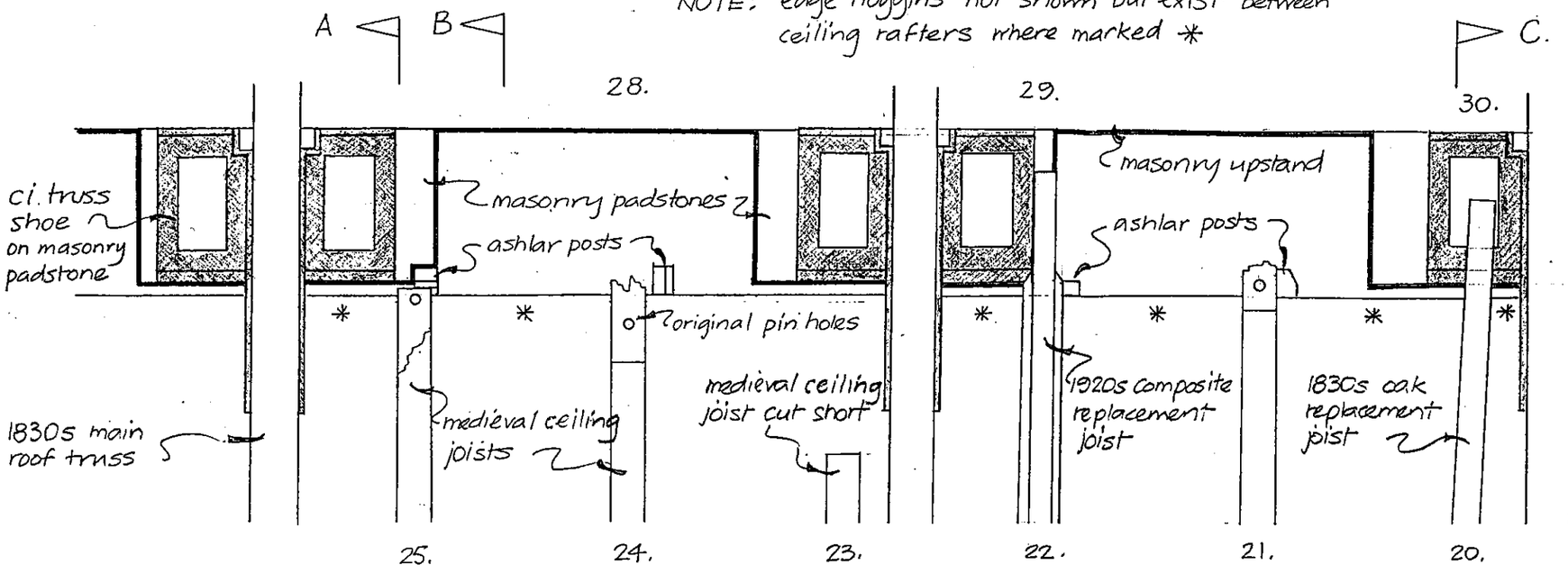
[26] Further investigation for Phase 3
[27] Pers. comm. to H Harrison Nov 1999
[28] Further investigation for Phase 3
[29] *Peterborough Cathedral Nave Ceiling Paintings: Scientific Examination Phase 2* Dr Ioanna Kakoulli, December 1999
[30] Further investigation for Phase 3

Laboratory should be approached to carry out this analysis. If variations in performance of different types of "animal" glue are discovered in the future, at least those caring for this ceiling will know what they are dealing with.

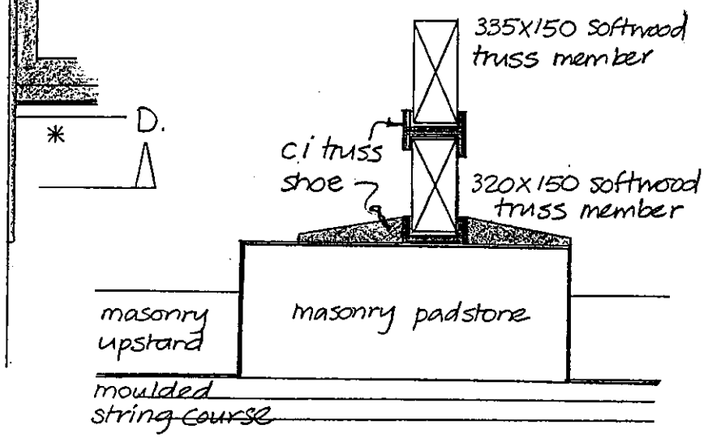
3.3.5.11 Further Documentary Research – Every source should be scoured to unearth any further documentary evidence of how the 1924/6 work was carried out[31].

[31] Further investigation for Phase 3

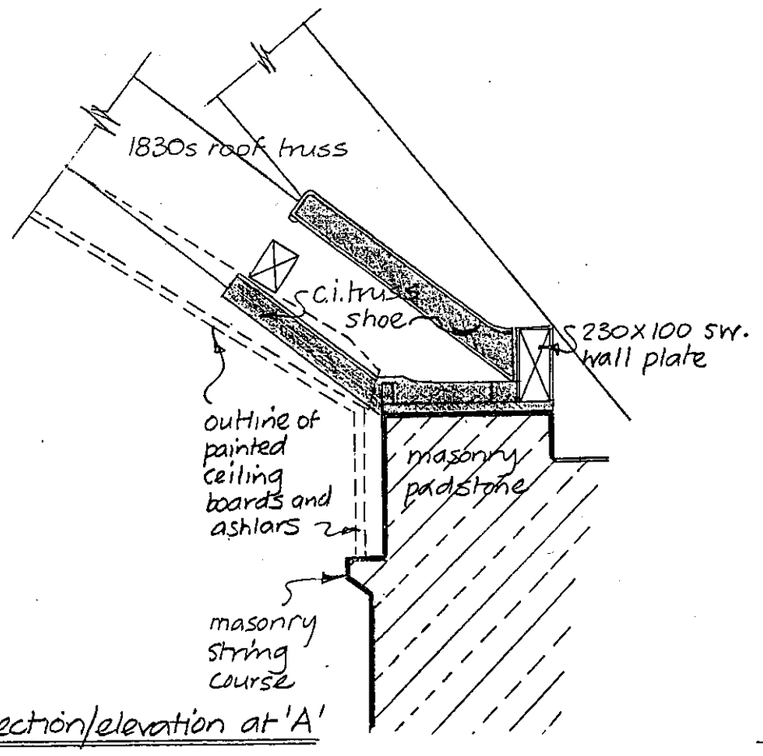
NOTE: edge noggins not shown but exist between ceiling rafters where marked *



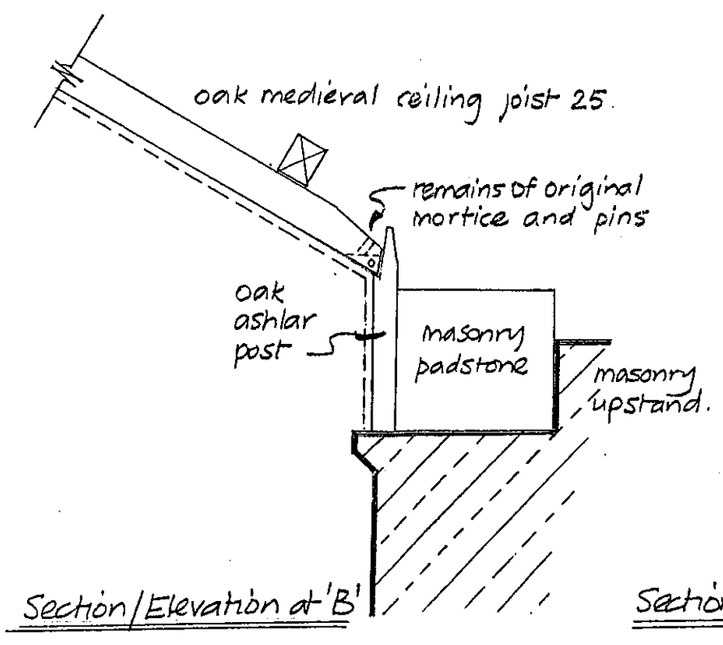
PART PLAN AT NORTH WALL showing layout of 1830s main roof trusses and medieval roof joists



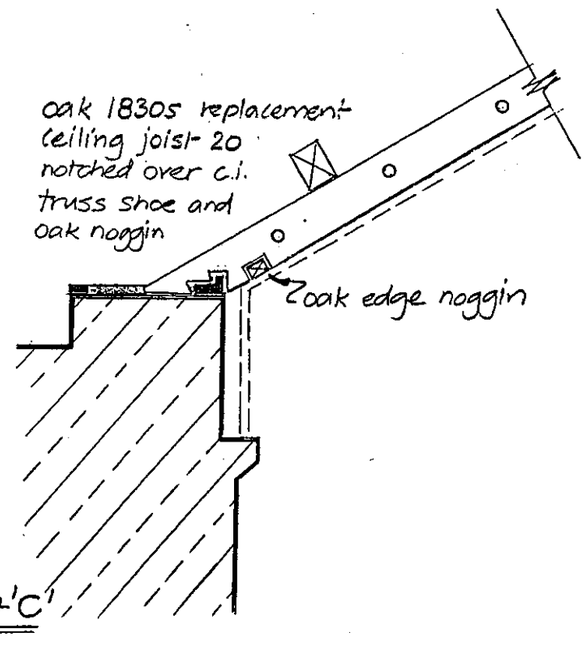
Section/elevation at 'D'



Section/elevation at 'A'



Section/Elevation at 'B'



Section/elevation at 'C'

PETERBOROUGH CATHEDRAL Typical Details of Existing Structure at Eaves

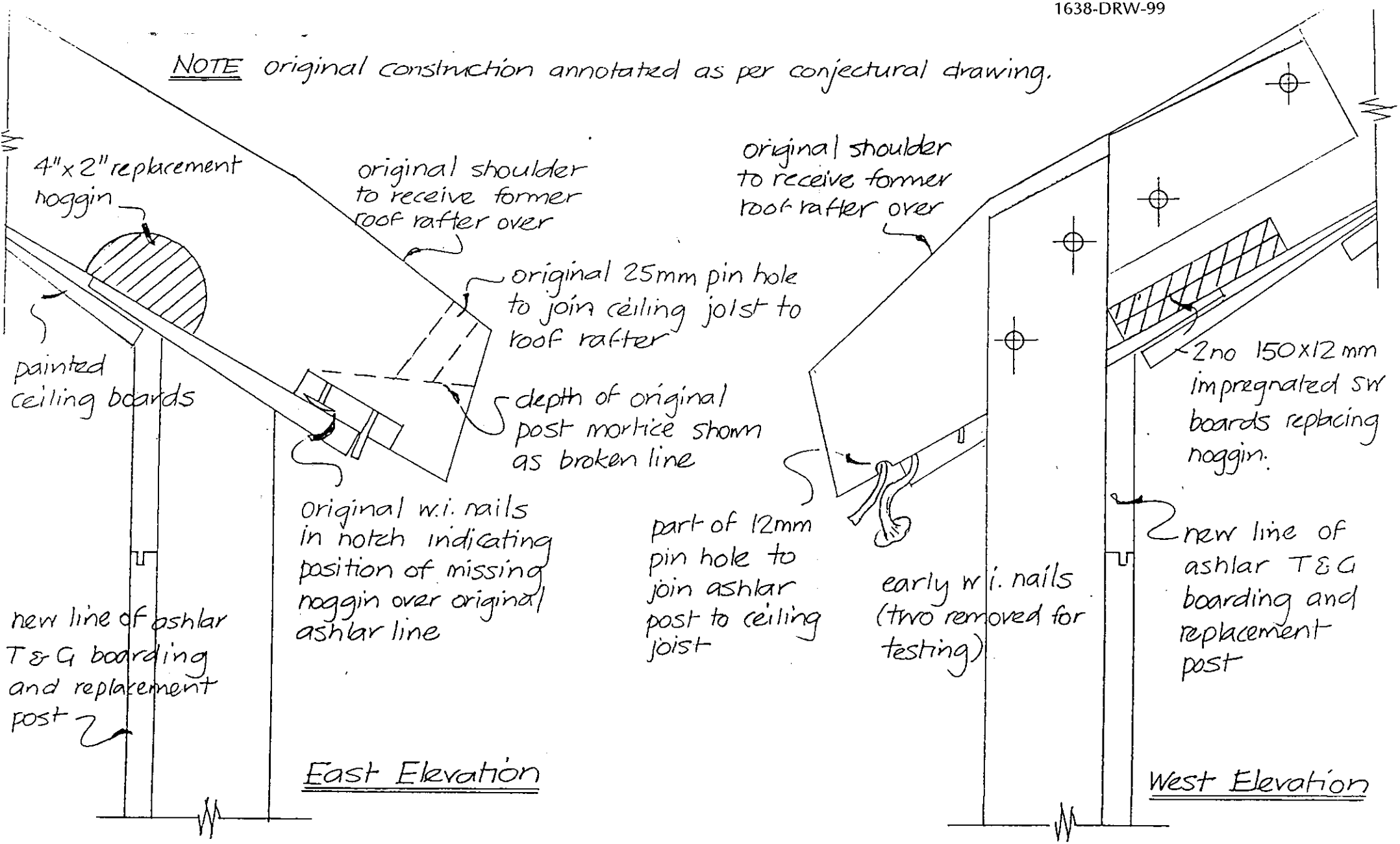
Scale 1:20

HUGH HARRISON CONSERVATION August 1999 drawn P G Ferguson.

Drawing 1

1638-DRW-99

NOTE original construction annotated as per conjectural drawing.



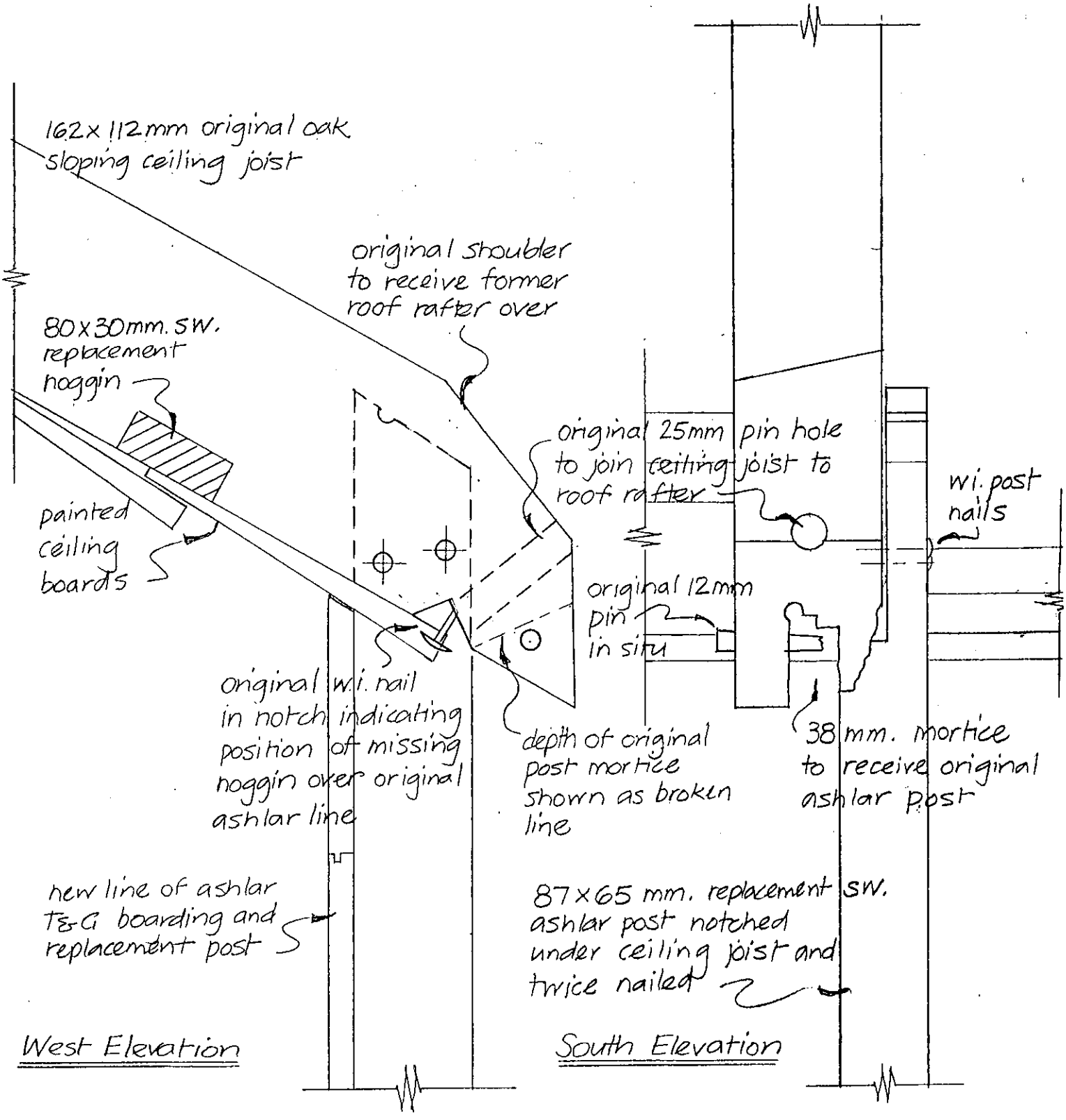
PETERBOROUGH CATHEDRAL Sloping Joist 9, North Side Eaves Detail Scale: ¼ F.S.

HUGH HARRISON CONSERVATION drawn P.G. Ferguson August '99

Drawing 2

NOTE

original construction annotated as per conjectural drawing



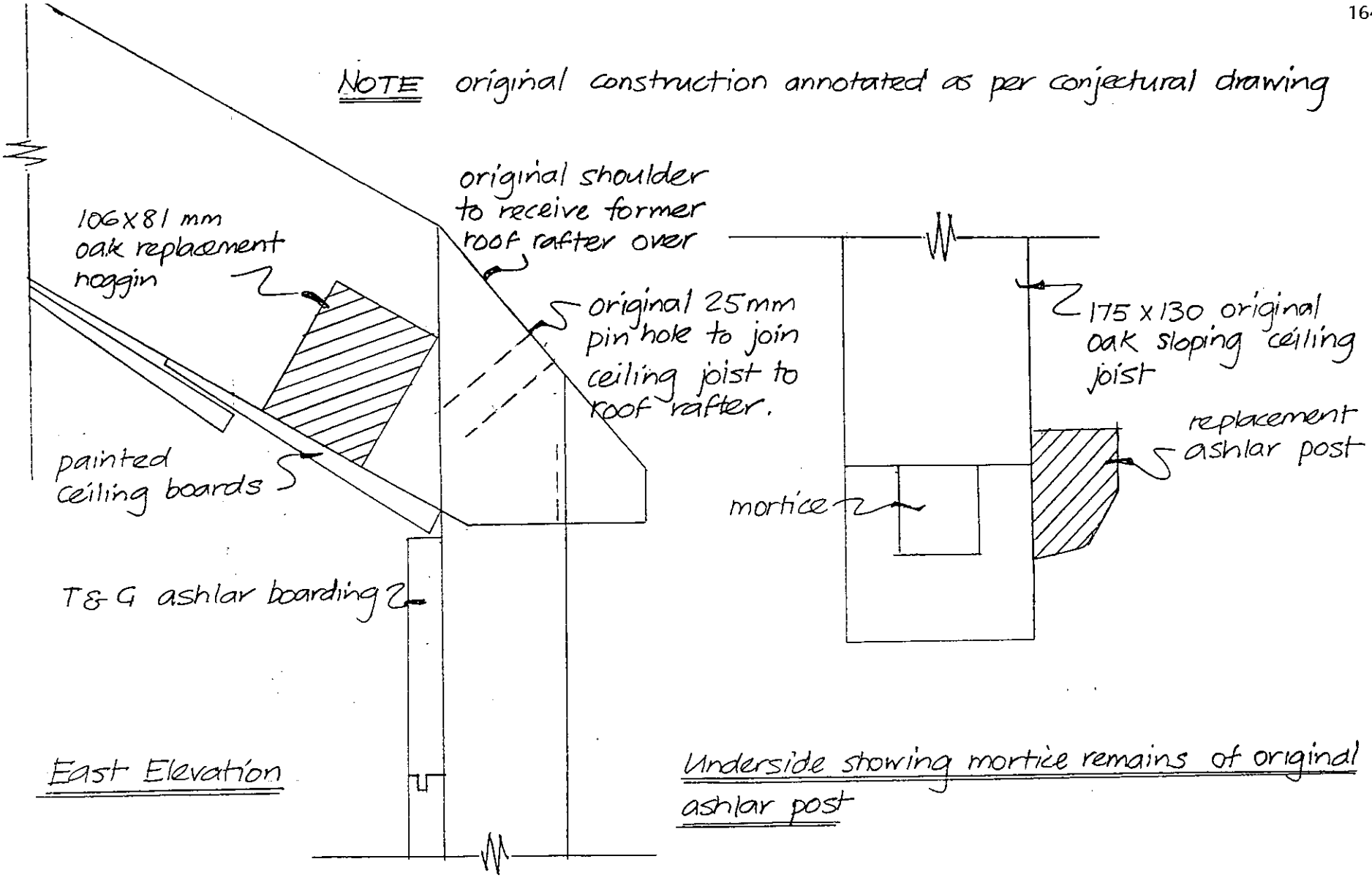
PETERBOROUGH CATHEDRAL Sloping Joist 13, South Side Eaves Detail

HUGH HARRISON CONSERVATION drawn P.G.Ferguson August '99

Scale: 1/4 FS.

Drawing 3

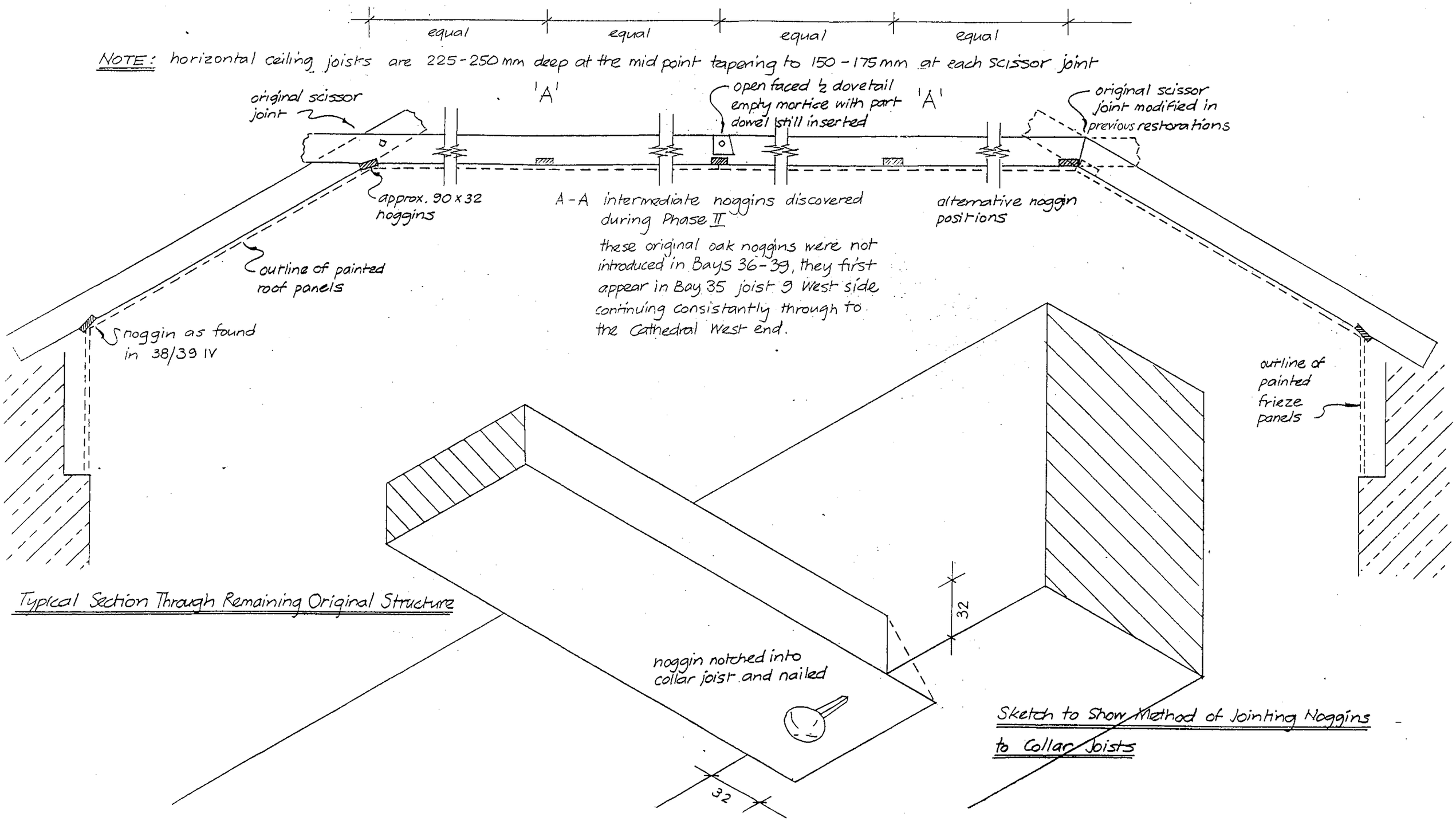
NOTE original construction annotated as per conjectural drawing



PETERBOROUGH CATHEDRAL Sloping Joist 16, North Side Eaves Detail Scale: ¼F.S

HUGH HARRISON CONSERVATION drawn P.G.Ferguson August '99

Drawing 4



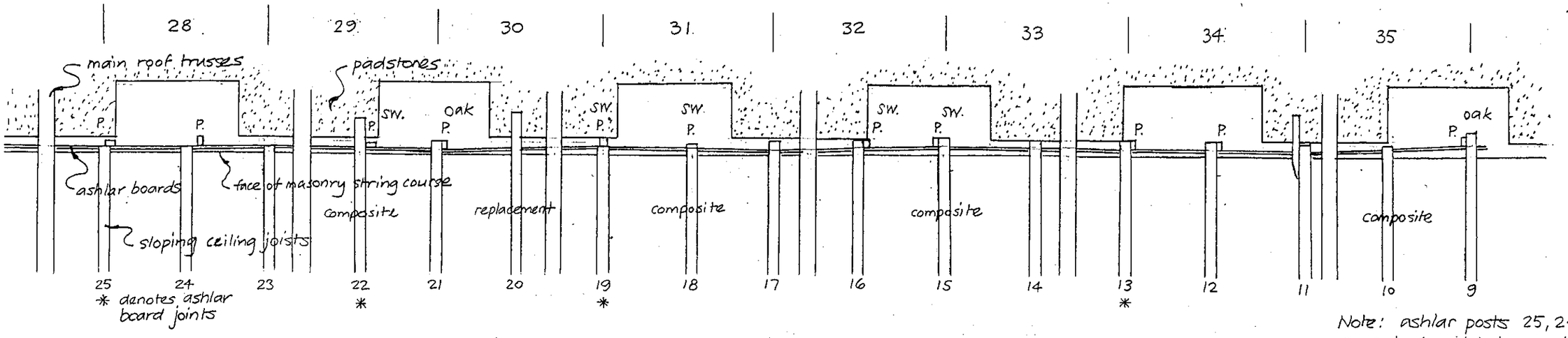
Typical Section Through Remaining Original Structure

Sketch to Show Method of Jointing Noggins to Collar Joists

PETERBOROUGH CATHEDRAL Existing Original Nave Roof Structure (1834 roof structure to which it is bolted not shown) Scale 1:20 ½ F.S.

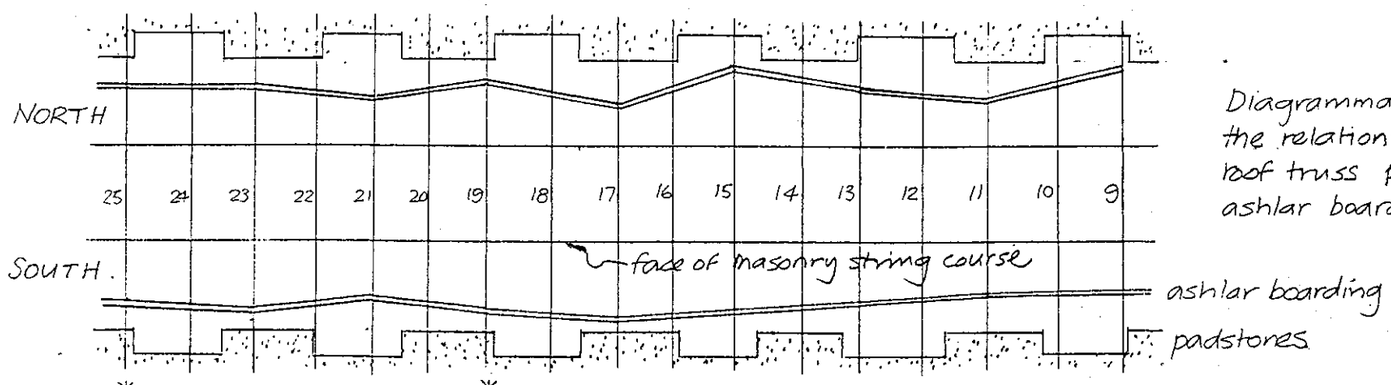
HUGH HARRISON CONSERVATION August 1999 drawn P.G. Ferguson.

Drawing 5

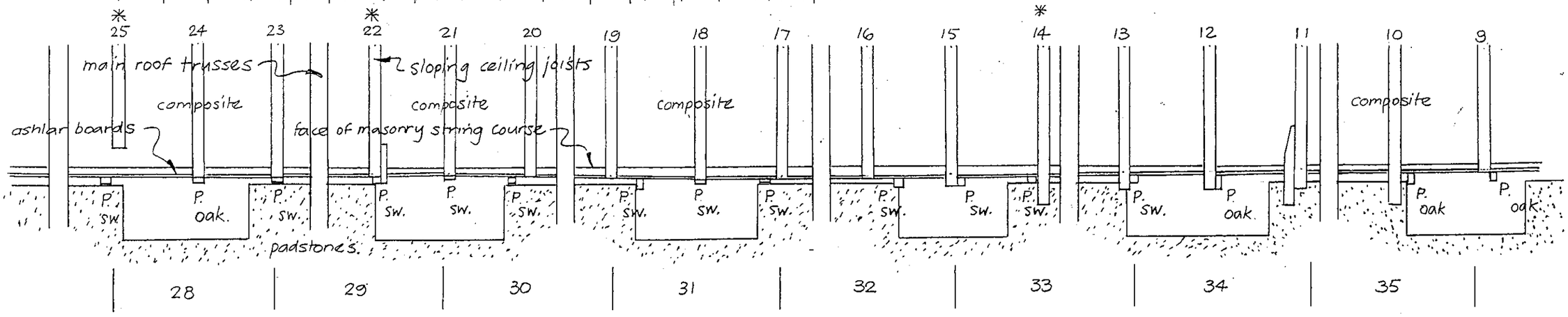


PLAN OF NORTH SIDE SHOWING RELATIONSHIP OF ASHLAR POSTS AND BOARDS TO MAIN ROOF TRUSS PADSTONES.

Note: ashlar posts 25, 24, 13, 12 believed to be oak but not recorded. Composite joist 10 may be attached to an ashlar post but not observed.



Diagrammatic representation of the relationship between the main roof truss padstones and the ashlar boarding.

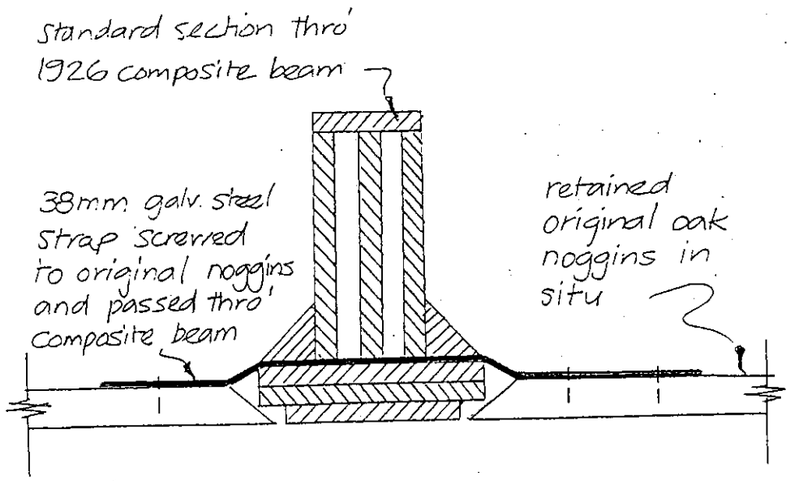


PLAN OF SOUTH SIDE SHOWING RELATIONSHIP OF ASHLAR POSTS AND BOARDS TO MAIN ROOF TRUSS PADSTONES

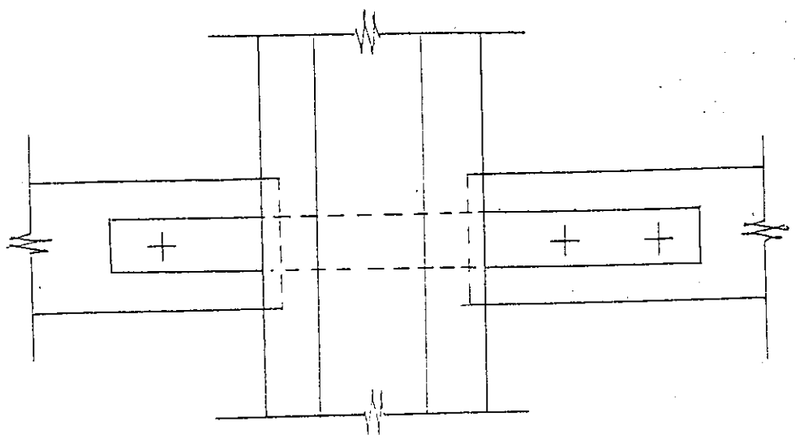
PETERBOROUGH CATHEDRAL Eaves Details Scale 1:40

HUGH HARRISON CONSERVATION August 1999 dramn P. G. Ferguson.

Drawing 6

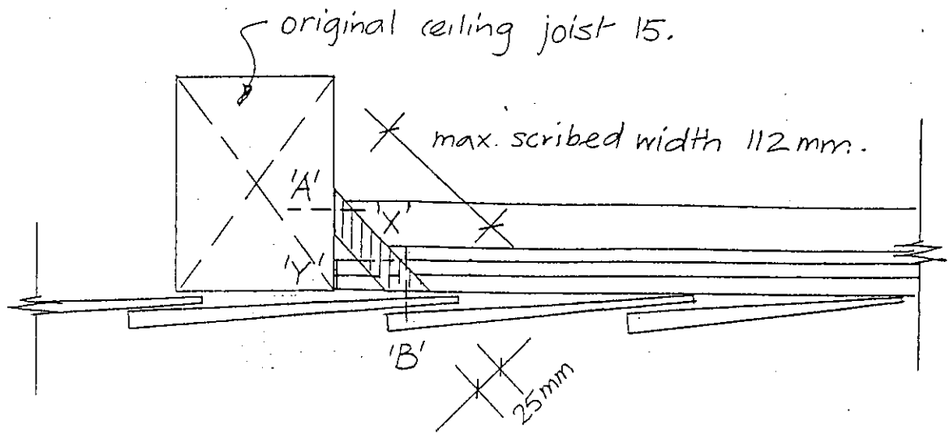


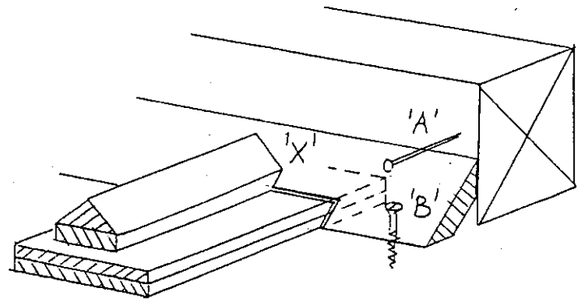
Section



Plan

Bay 34 II North, Ceiling Joist 12 method of supporting original oak intermediate noggins

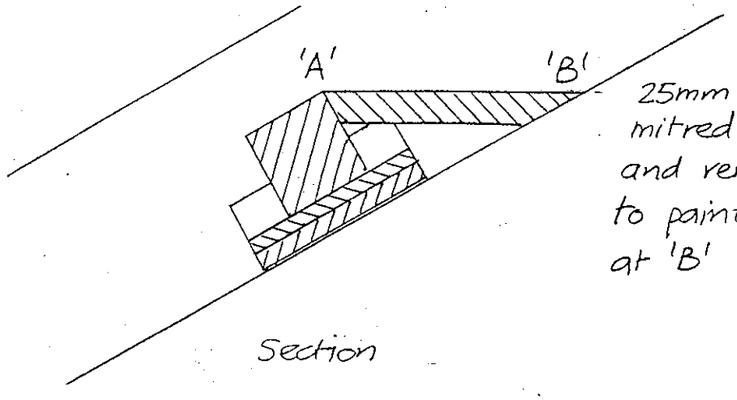




Sketch to show arrangement of covering board and noggin

Continuous ex. 25 x 150mm covering board scribed to diagonal boarding profile and notched over 2no. 150x12mm 1926 Noggin lower boards, covering board horizontally nailed to original oak ceiling joist 15 east side 'A' and vertically screwed down to diagonal boarding 'B' top two sections of 1926 Noggin rest on covering board at 'X', lower boards stop at east side of joist 15 at 'Y'

Method of Supporting Type 3 1926 Noggin Construction on East Side of Ceiling Joist 15.



25mm horizontal board mitred to noggin at 'A' and very carefully scribed to painted ceiling boards at 'B'

Section

Type 6 variation Bay 29 IV between sloping joists 22/21

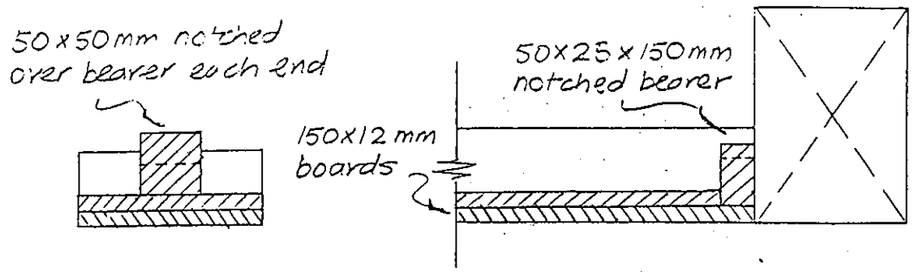
Note: — noggin continuous between original sloping joists 20/22 passing under 1926 composite sloping joist 21.

PETERBOROUGH CATHEDRAL Ceiling Noggin Details

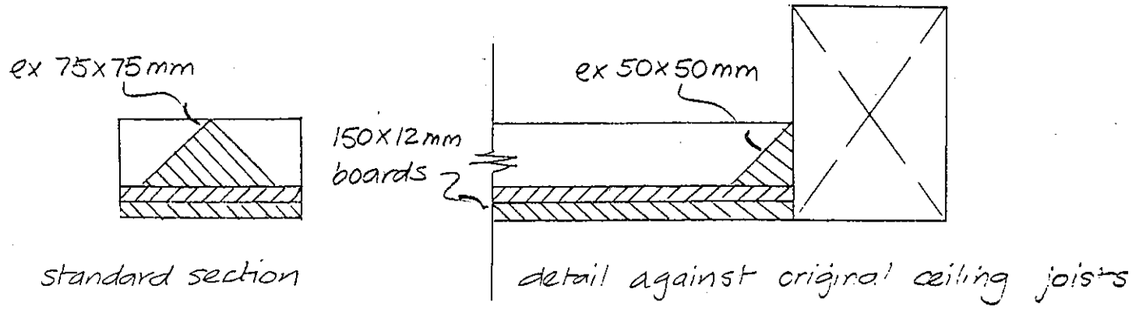
Scale 1:5

HUGH HARRISON CONSERVATION September 1999 dramn P.G. Ferguson.

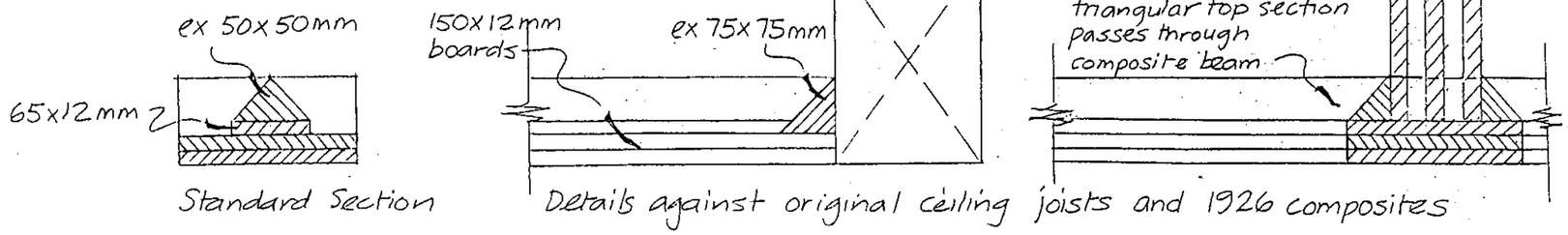
Drawing 7



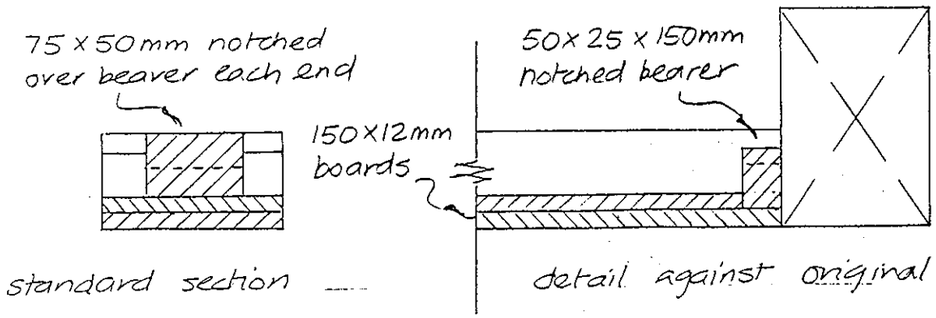
TYPE 1.



TYPE 2.



TYPE 3.



TYPE 4.

TYPE 5.

as for Type 1. but top section increased to 64 x 64mm.

TYPE 6.

as for Type 1. but top section increased to 76 x 76 mm.

PETERBOROUGH CATHEDRAL Ceiling Noggin Details

HUGH HARRISON CONSERVATION September 1999 drawn P.G. Ferguson

scale ¼F.S., 1:5

Drawing 8

PART 4: CONDITION: THE CEILING STRUCTURE, UPPER SIDE

4.1 ROOF TIMBERS

Evidence of old infestation by Common Furniture Beetle (CFB) can be found in the softwood roof timbers extensively but not intensively. No evidence of current infestation was found.

4.2 CEILING TIMBERS

No evidence of CFB infestation was found in any of the 1924 softwood noggins, joists, binders, or patches where they were revealed.

The flat and sloping joists are almost entirely free of any signs of any past infestation from either DWB or CFB.

4.3 BOARDS

Where the upper sides of ceiling boards were exposed, most showed signs of previous infestation by both CFB and DWB. None was seen to be active, nor had been active for many years. Surface decay was found, noticeable as a general softening of the surface and by miniature cross checking

Moore who was the last person to see the entire upper surface of the boards reported that it was "very dirty – as far as can be seen it is apparently free from decay". However one must add a note of caution in that he also says that the surface was covered with detached torching, so how detailed was his view of the surface is difficult to surmise.

4.4 FIXINGS

4.4.1 Pre 1830s

The only fixings that come in this category are the surviving pins holding the small number of complete halving joints at the intersection of the flat and sloping ceiling joists. Although no pins were extracted, the visible ends are in good condition and one would assume that they are sound throughout their length.

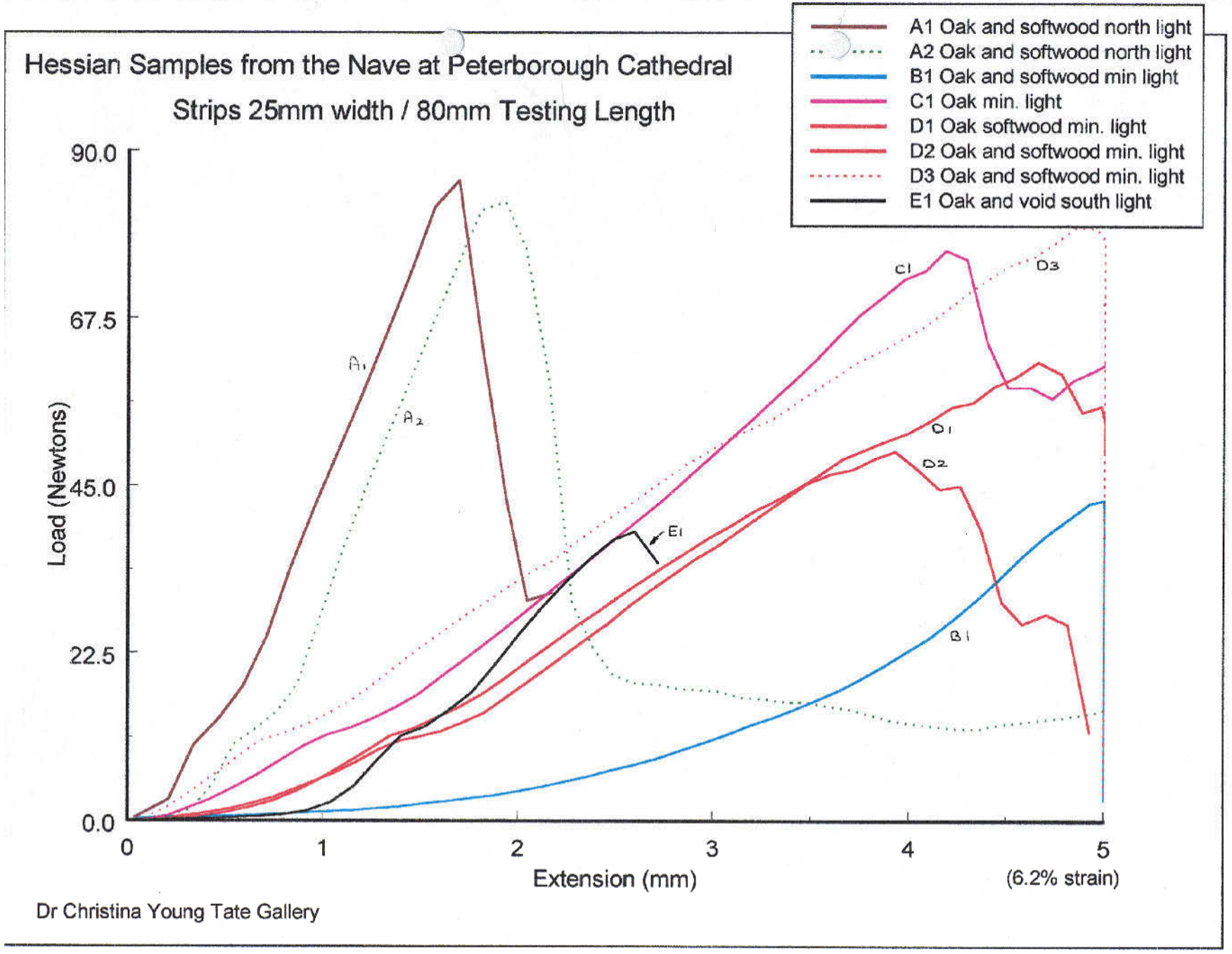


Figure 12. *Hessian samples from the Nave at Peterborough Cathedral Dr Christina Young, Tate Gallery*

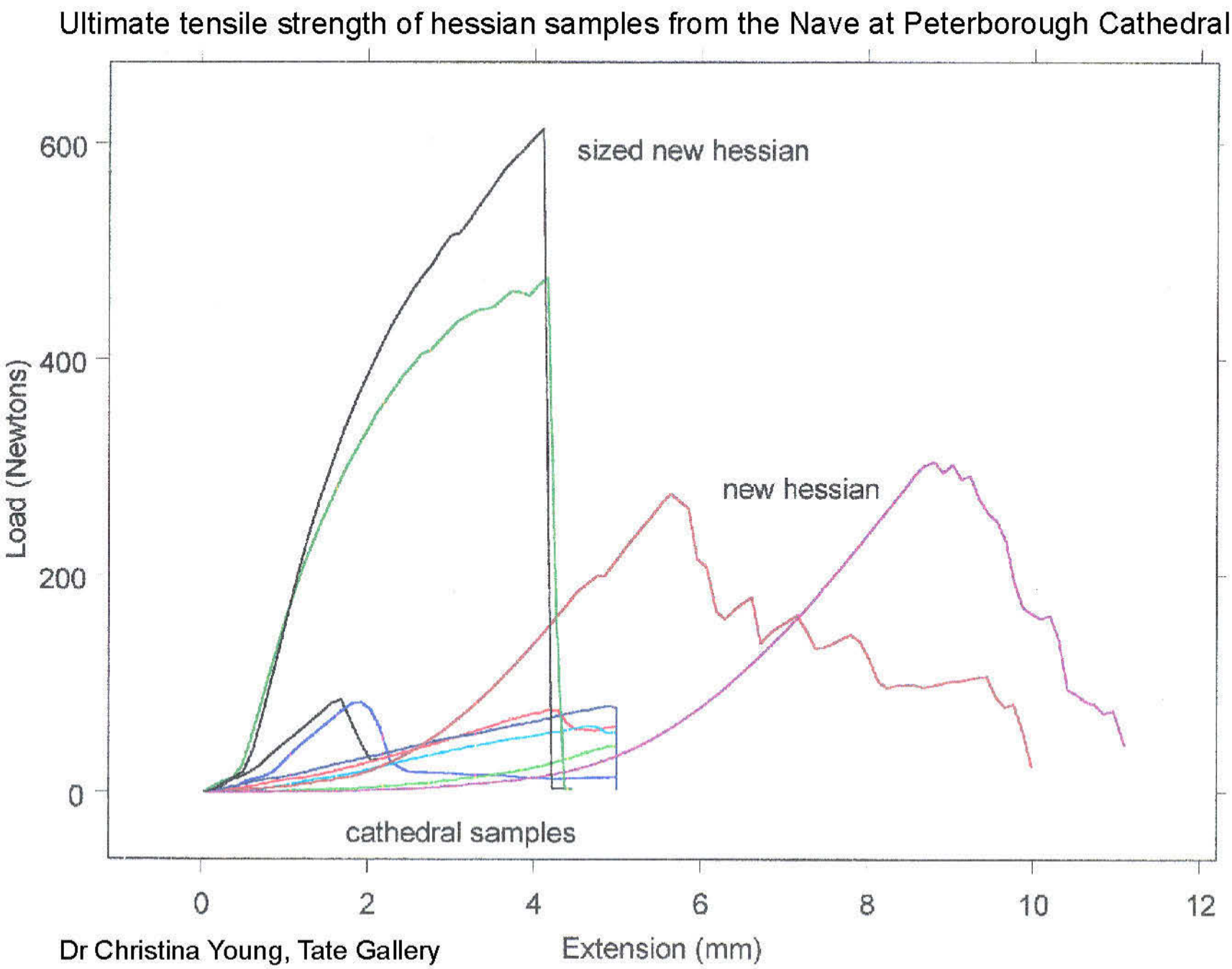


Figure 13. *Ultimate tensile strength of hessian samples from the Nave at Peterborough Cathedral Dr Christina Young, Tate Gallery*

4.4.2 1830

Light surface corrosion was found on the hanging bolts and nuts used by Blore.

The cast iron shoes are well painted, as was recommended to be carried out by Moore in his programme of works in 1924.

4.4.3 1924

The steel hangers used for the binders over the sloping ceiling were painted by Moore with a red oxide type paint along with the Blore iron work. Although steel was presumably used by Moore rather than the caste iron used by Blore, the paint surface still looks in good condition.

The visible heads of coach screws through the binders into the sloping ceiling joists and those used in the construction of the laminated joists seem to have a zinc or galvanised coating and are in satisfactory condition. Similarly, screws used to fasten laminated patches to the noggins are in a satisfactory condition. Nails used in the laminations and the triangular side pieces on the joists were not inspected but there seems no reason to think that they will be in any worse condition than in Phase 1.

4.5 HESSIAN

Analysis by Dr Christina Young at the Tate Gallery, proved that the hessian only retains 10%-15% of its original strength. Samples were taken from 5 locations:-

Table 1
Analysis of hessian by Dr Christina Young at the Tate Gallery

Sample No	Position	Light	Fixed to
A1/A2	Panel 29 I	Directly beneath North light	Oak and Softwood
B1	*Panel 31 II*	Dark	Oak and Softwood
C1	*Panel 33 III*	Dark	Oak
D1/D2/D3	*Panel 33 III*	Dark	Oak and Softwood
E1	*Panel 34 IV*	Directly beneath South light	Oak and over void

With samples A1/A2 and D1/D2/D3, the samples submitted were sufficiently large to be subdivided and tested separately, slightly different performances were attained with each sample in both groups, however the performance for the group is distinctive. **Figure 12** plots the results. It is remarkable to see that the samples from beneath the light failed far more quickly than those in the dark. The sample beneath the south light failed with only 1/3 the strain from that beneath the north light. The samples from the dark areas all performed in a comparatively similar way. Whether the acidity of the support (oak of softwood) had any effect is difficult to say. The results are so stunningly predictable that it is not recommended that any further tests are carried out.

To provide a comparison of present strength to original strength, samples of plain new hessian, and new hessian impregnated with scotch glue from Fiddes of Cardiff were tested in the same manner. **Figure 13** records the comparative failure points of both the hessian with glue- black and green lines; the plain hessian- brown and lilac lines; and the Cathedral samples- red, blue, green, purple and black lines. Again the results are amazingly predictable, and the comparison of the hessian with glue and the Cathedral samples providing a graphic reminder of the loss of strength from the hessian.

As the hessian provided the matrix which supported the ceiling panels, it would seem that its influence will continue to decline, and with continuing variations in the size of the timber, the glue which is quite brittle, will craze and in theory have less and less effect, particularly on the boards with a decayed upper surface. Those with a sound upper surface will remain more vulnerable, especially those which are heated by the sun where it must be assumed, the glue will continue to melt with rises in temperature and given the opportunity, penetrate further into the timber. Whether this is detrimental or not may need to be tested.[32]

Splits were found above softwood patches, see Item 3.2.5.6 above. The condition of the hessian looks satisfactory.

PART 5: CONDITION: THE CEILING STRUCTURE, LOWER SIDE

5.1 BOARDS

The condition of each board is described in the 'Board by Board Survey' and illustratively on **Graphics 6A/B**. All boards in all parts of the Ceiling covered by this Phase of work, are included in this report in two categories – Original and Replacement - in the description of each category of damage.

The boards are suffering from the following categories of damage

- Splits
- Wood losses
- Intended wood losses
- Infestation by CFB and DWB
- Wet rot
- Lead shot
- Surface degradation
- Impact damage/scratch marks
- Subsequent restorations (including repositioning and splinters from screws).

5.1.1 Splits

5.1.1.1 Original Boards - It would seem that almost all the splits are associated with the wood drying and contracting after being fixed in the Ceiling, see **Plate 117** where the nail is

[32] Further investigation for Phase 3

restraining a softwood board where one fragment is moving away from the piece that is held. By the same token the oak boards are only split once to relieve the tension in the wood whereas if the splits happened when the nails were first driven, it is likely that splits would have formed between the nails and the ends of the boards.

5.1.1.2 Replacement Boards - Although the replacement boards are split for the same reasons as the oak boards, the characteristics of the splits are quite different. These splits are not so wide, but they are very much longer. Splits between nails are also narrower and often they are very long – sometimes extending for the full length of the board. As there are knots in the softwood boards, there are also curved splits around the knots (see **Graphics 7A/B**).

5.1.2 Wood losses

5.1.2.1 Original Boards – Nearly all wood losses can be attributed to decay and infestation where the infestation has been so acute that the timber has been sufficiently reduced and weakened that it has freckled away, or detached by contact or rough handling during previous restorations A few other losses have occurred when boards were cut back and moved around when the replacement boards were inserted. All wood losses are shown on **Graphics 6A/B**.

5.1.2.2 Replacement Boards - All wood losses in the replacement boards are those incurred during fitting or subsequent restoration, none are attributable to beetle infestation or decay.

5.1.3 Intended wood losses

Plate 88 shows a number of holes or extended holes cut through the ceiling boards. These are recorded on the board by board survey sheets. It is difficult to know why these holes were made, the only recognisable patterns that might be mentioned at this time are that 5 holes are in a line approx. 650mm (600mm is 2'0") south of the north ceiling angle, 7 are on the centre line of the ceiling or close to 650mm south of it, and 3 are close to 650mm north of the south ceiling angle. Only one other hole in *Panel 29 IV* is outside these groups. The only other two losses are to do with repairs or fitting the boards. It should also be mentioned that the holes are grouped in the same rows, joists 13-14, 2 holes, joists 15-16, 2 holes, joists 16-17, 6 holes, joists 17-17, 2 holes, joists 21-22, 4 holes.

5.1.4 Infestation by CFB and DWB

Recording the intensity of infestation has been formalised in this Phase of work. The area of maximum intensity of exit holes for both death watch beetle and common furniture beetle is assessed on each board. A 25mm x 25mm frame is placed over this area and the number of exit holes counted and recorded on the Board by Board survey sheet. The maximum density is recorded for both species. The position of the recorded area(s) is recorded on the source documents.

5.1.4.1 Original Boards – Infestation by CFB and DWB is widespread (see **Graphics 6A/B**) and occurs both as general outbreaks throughout part of a board, or is concentrated in certain areas. The infestation may be heavy or isolated. Where it has been intense, so much of the wood has been consumed that it has crumbled away completely, and the adjacent areas that have survived are very fragile and vulnerable to damage see **Plates 35 and 80** .

No signs of current activity of either DWB or CFB were observed.

It is presumed that the upper surface of the boards was treated with Silvertown Solution in 1924, as specified by Moore.

There is slightly more infestation by DWB than CFB as one would expect in oak. As the upper surface of the boards is covered by the hessian, it is impossible to compare the incidence of exit holes through the upper unpainted surface with that through the lower painted surface

In view of the general preference by DWB to emerge through unpainted surfaces rather than through painted surfaces, many of which contained lead (though whether this is relevant or not, I do not know), it would be interesting to plot the exit holes through the raised areas compared with the abraded areas. If there is a provable reduction in holes in the former, this might indicate differences in composition of paint used on different areas[33].

There are many incidences of infestation along the outer (thick) edges of boards. It had been presumed that these areas represented sap wood, however when the boards were examined for dendrochronology, no sapwood edges were found. This phenomenon should be further investigated as there should be no reason why certain parts of boards are infested and not others if all the wood is heartwood.

5.1.4.2 Replacement Boards - There is consistent light infestation by CFB and negligible DWB.

5.1.5 Wet rot

5.1.5.1 Original Boards – In view of the large quantity of boards that have been replaced as well as the joists above, there are surprisingly few signs of wet rot on the remaining boards. Small areas do occur as shown on **Graphics 6A/B**. **Plates 115 and 116** show localised miniature cross checking of the surface and **Plate 127.** It should be emphasised that all this decay only exists on the surface.

5.1.5.2 Replacement Boards - There is no evidence of wet rot in any of these boards.

5.1.6 Lead shot

Samples of shot were sent to OIC The Weapons Collection, HQ Small Arms School Corps to see if they could be identified for date. Unfortunately Lt. Col A Wilson MBE was unable to help as the shot size varies between makers of guns, size of load and size of gun[34] (see **Appendix 11**). A comparison with modern shot used for game bird shooting puts the shot in this ceiling as nearly buck shot size!

Analysis of the boards with shot concerning the presence of paint in the shot holes confirms some important conclusions on dating various aspects of the ceiling see **Graphics 6A/B**. The most obvious conclusion is that the Ashlar boarding was installed in the 1830s as shot holes filled with paint (so they must be pre-1830) line the Ashlar boarding in *Panel 34 I.* If the boarding was also pre-1830 shot from the same discharge

[33] Further investigation for Phase 3
[34] Unpublished letter to H Harrison, 29 June 1999

would have strayed onto the Ashlar boards. The next interesting fact that seems to be proved by the shot is that several softwood boards with shot are found in isolation. This would seem to show that they are 1740s boards that have been moved, see for instance Board (x) *Panel 29 II* and **Plate 93**. The third feature is that Board (b) Panel 34 I has pre-1830s shot yet it has been identified as a re-used oak board. Up to now it has been assumed that the shifting around of original boards occurred in the 1830s,. it now seems that some were moved in the earlier restoration. The same can be said for Board (i) *Panel 30 IV* which is an isolated board with pre-1830s shot.

In several instances, the shot enters the wood at a very shallow angle such as the shot in *Panel 28 II* coming from the east. As this shot has been dated as post 1830s, could this be shot from discharges at pigeons that got inside the building during the tower reconstruction, and were shot from the scaffold for this work?

5.1.7 Surface Degradation

This concerns the shallow relief found on the surface of many of the original boards. Brian Ridout was asked to comment[35], but this is a phenomenon he had never come across before, nor could he find any other reference in his library. He speculates that the cause may be some sort of soft rot or differential collapse of the wood cells, or chemical deterioration from the old coke stoves.

In order to pursue this research, Brian Ridout would need samples of the timber. It is recommended that this research is carried out, not the least because another example of the phenomenon has been found in St. Albans Cathedral Choir ceiling[36].

On the basis that one line of thought considered the phenomenon could have been caused by differential protection of the surface (painted/unpainted, oil painted/thin limewash or size), it would be expected to find the same results beneath original nail heads. Where these are still in position, the phenomenon cannot be seen, but where the nails are now lost some signs might be found. **Plates 118 -119** go some way to confirming the theory.

Plate 118 shows deeply etched grooves between the medullary rays which virtually disappear where they were covered by the nail head. It should also be noted that the striated surfaces started as the raised areas between the grooves.

Plate 119 is exceptionally interesting because in many places on the grooved boards, what used to be the raised ground between the grooves has now sunk back to be the irregular ground below the flat smooth surface of the base of the groove se also **Plate 118** above. This makes the appearance of the grooved boards quite deceptive in places, and one has to keep remembering that the flat surfaces are the base of the grooves, and the rough strips are/were the actual original surface of the board. If Plate 119 is viewed as displayed in its sleeve, it will be seen that the left hand nail head below the horizontal joint is missing. Above the shank of the nail there is a segment of timber still raised at its original height that has only survived where it has been protected by the nail head. All the rest of the raised strip has disappeared.

[35] Unpublished letter to J Limentani, 23 June 1999
[36] Further investigations for Phase 3

5.1.8 Impact Damage/Scratch marks

Considerable surface damage has been recorded on the board by board survey sheets, it seems to be of three basic types. Hammer marks from misplaced blows to drive nails from below or clench over nail ends from above (**Plates 84-85**), glancing blows from a hammer head to position boards (**Plates 84** and **92**), what looks like damage from scaffold tubes east of joist 14 (*Panel 33 III*), and scratch marks which may or may not be location marks.

5.1.9 Subsequent Restorations

Many of the boards, both original and replacement have been damaged by later interventions. These can be put into three categories,

5.1.9.1 Displaced Boards, Lateral – These are boards that have been removed and replaced out of alignment in either 1740 or 1830, and are recorded on the Board by Board Survey sheets with the distance in millimetres and direction of displacement (N, S, E, W).

5.1.9.2 Displaced Boards, Vertical – these are boards which were displaced vertically by screws inserted in the 1924/6 restoration and are also recorded on the Board by Board Survey sheets, with the distance in millimetres that the board has been displaced. The cardinal point recorded in the next column identifies the edge of the board where the displacement has been recorded. A good example can be seen in **Plate 129**.

5.1.9.3 Splinters- As screws were inserted from above in the 1924/6 restoration, when they emerged through the underside of the Ceiling board, many splintered the surface. A good example in a softwood replacement board can be seen in **Plate 145** and **Graphic 6A/B**.

5.1.9.4 Surface Abrasion- **Plates 97-98** show abrasion to the painted surface caused by the hanging bolt washers turning against the ceiling boards. This can only be attributed to carelessness in the course of fitting the bolts, with no one below holding the washer as his colleague tightened the nut above. Whether the impact damage from a square headed hammer in Plate 98 is associated with trying to restrain the washer one cannot tell, but there is no other reason for this damage on this board.

5.1.10 Fixings

There is slight surface corrosion on the nail and hanging bolt heads wherever the paint has detached. Some original nails have come loose and were taken out by Julian Limentani during his initial inspection. A small number of other nails were loose but could not be extracted as they were clenched over above the ceiling boards.

Nearly all the screw ends from the 1924 restoration showed signs of corrosion, whether they are steel or zinc plated. There was no sign of the shanks having corroded to the extent that they were putting sufficient pressure on the wood to split it.

PART 6: TREATMENT TESTS: THE CEILING STRUCTURE

6.1 PHASE 2 TREATMENT TESTING

No further tests were required as no new treatment materials or techniques were used during Phase 2.

PART 7: TREATMENT: THE CEILING STRUCTURE

7.1 GENERAL

The broad categories of repair include:-

- cleaning all upper ceiling surfaces,
- work to the hanging bolts,
- replacement of screws to which there is access above the ceiling and re-fixing splinters,
- supporting detached or partially detached fragments of ceiling board,
- replacing windows cut in the hessian with sailcloth,
- consolidation of fragile areas of decay,
- gluing splits,
- fillings,
- re-integration with timber inserts.

All strategies for repair as agreed in Phase 1 were continued in Phase 2.

7.2. CLEANING ABOVE CEILING

Before work commences the boundaries of the scaffold below the ceiling are marked with danger tape. The cleaning is carried out using "Henry" vacuum cleaners using only the brush attachments. Ear defenders, masks and protective clothing is worn at all times. All debris is bagged up, labelled and stored in the east tribune gallery of the north transept, for subsequent sorting and assessment by archaeologists[37].

[37] Organise sifting of debris in bags from ceiling space during Phase 3

7.3 HANGING BOLTS

The hanging bolts were taken out in the agreed manner using the joist carrier, the hanging bolt grips and the hanging bolt extractor where needed see **Plate 125** where Bob Chappell is assisting below the ceiling. Before each bolt was extracted a telltale was set up to measure any change in relative distance between the binder and the joist.

In their place temporary stainless steel bolts were installed see **Plate 128**. After extraction the bolts are rubbed down lightly and painted with first the Trimite SAP3 2 Pack Self Etching Primer[38], then within 16 hours the Trimite 2 Pack Acrylic finish AE262[39]. This is then left to harden for 24 hours before the bolts are replaced. The thread is not painted, nor the head of the bolt see **Plate 95**. This is coated with Paraloid B72 by the Perry Lithgow Partnership.

The top washer is painted both sides, but only the top surface of the bottom washer. The sides and bottom of this washer are treated with Paraloid B72 by the Perry Lithgow Partnership.

Before the bolts are replaced the empty holes in the joists and binders are carefully but thoroughly cleared through with the 22mm threaded stud used for the temporary bolts see **Plate 126** where Bob Chappell is performing this task.

The hanging bolts are assembled as per David Goode's Specification using 40mm x 20.4mm x 2mm spring steel washers, supplied by Skegness Springs Ltd, see **Plate 124** where Bob Chappell and Cameron Stewart are preparing to take out a temporary bolt prior to reinserting an original bolt.. Plastazote LD45[40] packers (6mm) are cut to the size of the washers and positioned between the washer and the ceiling as in **Plate 127**. Before the nuts are fitted, the thread of the bolts are coated with Castrol LMX Heavy Duty Grease[41].

After setting up each bolt, a simple telltale system using one piece of batten screwed to the binder and another to the joist are fitted so that the corners of the two battens just touch. It will be easy to measure any deflection in the future by measuring either the gap between the pieces, or the overlap.

7.4 SCREWS AND SPLINTERS

All screws which projected below the ceiling to which there was access from above without dismantling any woodwork were taken out and replaced with shorter stainless steel screws. There were fewer screws in this category in this Phase compared with Phase 1, and most of those replaced were found beneath 1924/6 patches, see **Graphics 7A/B** . Each protruding screw was connected to a live lead from a 6v battery, the other lead of which was threaded up through an existing hole in the ceiling and was wired to a probe with detector bulb. **Plate 132** shows Claire Cully measuring a new protruding from a screw already located above the ceiling. She is in constant communication with

[38] A 2 pack Primer consisting of a zinc tetroxychromate pigmented base and an acid solution, supplied by Trimite Ltd.
[39] A 2 pack acrylic Finish free of isocyanates, supplied by Trimite Ltd.
[40] Plastazote foam is a closed cell, low density, cross-linked polyethylene foam, supplied by Polyformes Ltd.
[41] A high performance lithium complex Grease, supplied by Castrol Lubricants.

her colleague above the ceiling with a walkie-talkie link. Initial location is done with the metal detector seen in the foreground of **Plate 134**. Final location is confirmed with the probe with the detector bulb also in **Plate 134**, and in action in Bob Chappell's hands in **Plate 131,** and having successfully located the screw, **Plate 133** shows it being extracted.

After locating the screw, tiny windows were cut in the hessian, but towards the end of this Phase of work, it was found that the hessian could be cut solely across the screw head, and the screw withdrawn without cutting a larger hole in the hessian, see **Plates 141-142**.

The only other screws to be replaced were the central screws in the noggins which fix the top stiffening bars or triangles to the top of the noggins. As these screws could have some sort of structural role, it was felt a worthwhile precaution to exchange these for stainless steel. In many places it was found that the original screws were too short to even enter the top laminate, let alone the bottom laminate. This error really meant that the affected noggins were unconnected to the very structural member of the noggin which was designed to carry the weight from the centre of the span to the joist at each end[42]. **Plate 140** shows Jonathan Porter carrying out this work.

Where splinters of wood have been created by protruding screw ends as in **Plates 129** and **145**, these are repositioned and adhered with a solution of Plextol B500[43] (diluted 1:1). Where necessary presses were applied overnight to ensure a firm bond as in **Plate 122**. A reattached splinter can just be seen in **Plate 146** in the central area painted black.

A rather bigger splinter in *Panel 28 III* **(Plate 120)**, presumably caused by a blow from above was mended in exactly the same way as the smaller splinters, except that the surface was first protected with Eltolene tissue adhered with Paraloid B72[44], see **Plate 121**. The fragments were eased and manipulated back into position, and glued with Plextol B500, and presses were left overnight as in **Plate 122**. The finished repair is seen in **Plate 123** after the tissue had been removed by dissolving the adhesive using acetone.

7.5 STAINLESS STEEL FIXINGS

The basis for the specification for repair was an assessment of how secure each board or fragment was. The repairs consisted of securing loose pieces with 3mm threaded stainless steel studding bent over to form an angle with an average length across of 12mm, fixed above the Ceiling with nuts and washers. In some instances the studding was bent a second time to form a hoop, with either the second leg cut off say 3mm above the angle, or returning above the Ceiling and secured with a second nut and washer. The third type of fastener used were stainless steel screws with washers, average size 25mm No 8's, some were a little longer and some a little shorter.

Wherever possible old screw holes were used, or the fixings were placed between boards, or in splits. If no suitable hole or split was available, the type of fixing may have been changed from a screw to an angle if that enabled the fixing to be inserted without drilling through an original board. Tiny pieces of Melinex[45] were inserted between the angle bolts and the painted surface. All stainless steel fixings below the Ceiling were touched

[42] Are these screws recorded , if not they should be in the next Phase.
[43] Plextol B500 is an aqueous dispersion of a thermoplastic acrylic resin. A product of Röhm.
[44] Paraloid B72 is an ethyl methacrylate co-polymer. A product of Röhm Hass
[45] Archival polyester (ICI Melinex®) 75mc

in with acrylic colour to prevent any chance of reflecting the light and being seen from the floor (see **Graphic 7A/B**).

Each board was examined and the specification for each repair was listed (see Table 2).

Table 2.
Specification of Phase 2 repairs to ceiling boards.

Panel	Board #	Specification
35 I	J	South end, screw and washer to retain pointed end.
35 I	D	South end, fragment by nail secured with Plextol B500.
	I	North end, screw and washer to support west edge.
	W	South end, secure detached flake of wood with Plextol B500.
	Y	South end, screw and washer to retain vertical displaced fragment next to nail.
	L	South end, screw and washer through existing nail hole at tip to retain loose fragment.
35 III	U	North end, hooped threaded rod to retain fragment. See diagram.
	AA	North end, Plextol B500 to retain small fragment in area of timber loss.
	BB	North end, Plextol to retain detached split by nail hole.
	AA	South end, two screws with washers to retain east side of break, plus threaded rod in existing nail hole in adjacent board to support separate break.
	S	South end, screw and washer in main part of board (with threaded rod from adjacent split board).
	M	South end, threaded rod. See diagram.
	E	North end, screw and washer through existing nail hole to retain split.
	J	East end, screw and washer through existing nail hole to secure splits, with threaded rod on south edge.
35 IV	D	South end, screw and washer to retain split.
	W	Three screws and washers either side of east and central fragment. West fragment secured with screw from above.
34 I	O	North end, screw and washer through existing nail hole to secure split.
	Q	Two screws and washers through split and west edge to secure split and main board. Screw and washer, South end, on west corner to secure split.
34 II	W	South end, stainless steel screw and washers through existing holes through scarf.
	N	South end, secure fragment with Plextol B500 by east nail head.
	J	North end, secure loose fragment on west edge with Plextol B500 and wedge.
	E	Secure splits by nail hole on west edge with Plextol B500.

Panel	Board #	Specification
34 III	B	South end, screw and washer through existing nail hole to retain split over edge of hole.
	C	South end, secure west edge of split with Plextol B500
	D	With supervision of PLP, remove misplaced fragment with surface paint, and fit to original position. At south end of split by nail, secure open joints and broken end of board with Plextol B500
	E	North end, secure fragment on east side of split with Plextol B500.
	K	North end, secure west edge of fragment with Plextol B500.
	L	Centre and south end, secure loose fragments with Plextol B500.
	M	North end, stainless steel screw and washer through existing nail hole into noggin to secure end of board.
	N	South end, threaded rod on east edge to secure loose split.
34 IV	AA	South end, stainless steel screw and washer through existing nail hole to secure split on east edge.
	R	North end, stainless steel screw and washer through existing nail hole on east edge to secure split.
	F	North end, stainless steel bolt and washer through existing nail hole to secure split.
33 I	F	South end, secure fragment with split at nail hole on the west edge with Plextol B500.
	R	Stainless steel screw and washer through existing nail hole beside nail, centre of board, to secure part of board split down its length on the east edge.
	X	North end, threaded rods as per diagram to retain loose fragment on west edge. Inject Plextol B500 into worm eaten timber beneath east edge of board Y to retain fragments.
33 II	A	South end, secure through existing nail hole using stainless steel screw and washer (before Board B is replaced with new oak). North end, secure loose fragment with Plextol B500.
	B	Stainless steel screw and washer to secure tip.
	H	South end, stainless steel screw and washer through existing nail hole to secure end of board. North end, secure fragment on east edge, which is resting on board F with Plextol B500.
	J 1	North end, secure part of board without a nail with two stainless steel screws and washers either side of splits.
	W	South end, secure west edge of broken board with two stainless steel screws and washers.
33 III	N	South edge, secure split with two threaded rods and glue with Plextol B500. See **Plate 135**
	D	North end, secure fragment split off tip of board with stainless steel screw and washer.
32 I	D	North end, threaded rod on west edge to secure split in board.
	E	North end, threaded rod on the west edge through original nail hole to secure loose split.

Panel	Board #	Specification
	X	West edge secure split in board with stainless steel screw and washer.
32 II	L	South end scarf joint, secure loose fragment with Plextol B500
32 III	F	North end, secure loose worm eaten fragment on east edge with Plextol B500.
	J	North end, secure worm eaten fragment on east edge with threaded rod.
	U	Centre secure board with Stainless steel bolt and washer.
32 IV	U	North end, stainless steel screw and washer in existing nail hole to secure end of board.
	BB	South end, secure fragment on east edge with stainless steel screw and washer on each side.
31 I	Z	Insert threaded rod through unpainted edge of board Y to secure split on east edge of board Z.
31 III	D	North end, stainless steel screw and washer through existing nail hole (1 ¼" slot) to secure split.
	H	North end, screw and washer through point to secure broken tip caused by nail.
31 V	B	North end, east edge, threaded rod through noggin to retain fragment also Plextol B500 in bottom edge. Also stainless steel screw and washer through existing nail. Centre, insert threaded rod on west edge of split to hold detached section.
30 I	N	North of centre on the east edge, insert threaded rod through existing nail hole and wrap rod around loose section of board to hold in place.
	Q	South end, insert stainless steel screw and washer through existing nail hole on east edge of board to retain split. Ease split into original position before installing fixing.
	K	South end, stainless steel screw and washer into replacement board east edge to secure split.
30 II	A	North end, stainless steel screw and washer through existing nail hole to retain loose split.
	B	South end, threaded rod through existing nail hole, west edge, to retain split
	D	Secure loose board tip with two stainless steel screws and washers.
	E	North end, stainless steel screw and washer to retain end and point of board broken by nail.
	U	South end, stainless screw and washer through existing nail hole to secure end of board at scarf. Plextol B500 east edge.
	V	South end, screw and washer through existing nail hole to retain loose board.

Panel	Board #	Specification
	AA	South end, stainless steel screw and washer through existing nail hole to support board in existing position. See **Plate 137.**
	BB	South end, stainless steel screw and washer through existing nail hole to secure board.
30 III	T	North end, threaded rod on east edge to support worm eaten split.
	V	North end, screw and washer through existing nail hole at point of board to give support to fractured end. Insert Plextol B500 into fracture.
	X	North end, stainless steel screw and washer through existing nail hole to give support to board.
	DD	Three screws and washers to secure board which is loose. See diagram.
30 IV	N	South end, west side, stainless steel screw and washer in existing nail hole.
	I	South end, west edge, secure loose fragment with Plextol B500.
29 I	T	North end, east edge, two screws and washers to secure split.
	S	North end, secure broken edges of boards which are worm eaten with Plextol B500.
	I	North end, west edge, secure loose fragment with Plextol B500.
	T	South end, stainless steel screw and washer through existing nail hole to retain broken end of board.
29 II	B	South end, stainless steel screw and washer through existing nail hole to secure board. See **Plate 137.**
	G	North of centre, insert threaded rod beside washer of bolt to help support splits in board. Centre, inject Plextol B500 into small surface split in west edge.
	H	South end, secure small fragment at tip of board, also small fragment on east edge with Plextol B500.
	L	Stainless steel screw and washer through existing nail hole to give support to worm infested board. South end, screw and washer to support fractured end.
	M	South end, east edge, two screws and washers into joist to support broken end.
	Q	South end, west edge, threaded rod to retain loose fragment within split to give support.
	S	North end, secure fragment with Plextol B500. Wedge in place till dry.
	X	Stainless steel screw and washer through existing nail hole on east edge to secure split.
	CC	Carefully remove broken part of board, reposition and fix with stainless steel screw and washer through existing nail hole.
29 III	E	South end, west edge, one threaded rod to support fragile edge due to infestation near bolt. Threaded rod west edge to secure broken fragment by nail. Plextol fragile edge next to bolt head.

Panel	Board #	Specification
	E	South end, one threaded rod to support fragile fragment on west edge next to nail.
	G	South end, threaded rod to support split.
	K	South end, east edge, Plextol small fragment to secure.
	M	Plextol fragment east edge in centre to secure worm infested fragment.
	O	South end, west edge, stainless steel screw and washer through existing nail hole at split to retain.
29 IV	D	South end, stainless steel screw and washer through existing nail hole to secure board.
	F	South end, stainless steel screw and washer through existing nail hole.
	J	North end, one stainless steel screw with washer to secure loose board. North end, one threaded rod to secure remainder of board.
	Q	North end, east edge, stainless steel screw and washer through existing nail hole to secure split. South end, insert stainless steel screw and washer in east edge of board.
28 I	X	South end, east edge, threaded rod through existing nail hole to support split.
	V	South end, east edge, stainless steel screw and washer to secure large split.
	R	North end, two screw and washers as diagram, within missing part of board to retain both splits, plus thread rod on west edge.
	O	South end, west side, threaded rod within hole caused by worm infestation to retain split end of board. Inject Plextol B500 around surrounding area to help fix. See **Plate 136**
	K	North end, west edge, secure edge split away by nail with Plextol B500.
28 II	A	South end, west edge, threaded rod through existing nail hole to retain split.
	C	North end, stainless steel screw and washer through existing nail hole to secure broken end.
	H	North end, secure very small fragment between end of board and nail head with Plextol B500.
	P	North end, stainless steel screw and washer through existing nail hole to support end of board.
	R	North of centre, secure worm infested fragment in west edge with Plextol B500.
	V	South end, west edge, stainless steel screw and washer to support thin end of board.
28 III	B	North end, threaded rod by nail to hold split. Secure fragment in same area with Plextol B500.

Panel	Board #	Specification
	C	North end, east edge, secure fragile area with Plextol B500 also from above, brace off scaffold with folding wedges overnight for Plextol B500 to cure. South end, secure point of board with Plextol B500.
	I	Secure split on west edge with Plextol B500. Tape until cured.
	A	Secure split on east side with Plextol B500, Tape until cured.
	BB	South end, east edge, threaded rod through noggin to support split. North end, west edge, stainless steel screw and washer through noggin to support split.
28 IV	O	Stainless steel screw and washer through existing nail hole next to split on east side to secure.
	N	North end, west edge, stainless steel screw and washer through existing nail hole to help fix whole board.
	H	North end, secure fragment east edge with Plextol B500, and hold in place with wooden wedge until cured.
	D	South end, west edge, stainless steel screw and washer to secure split.
	C	North end, west edge, threaded rod through existing nail hole to retain split to the east of the hole. Secure split opposite with Plextol B500
34 I	Ashlar Post	Put screw into Ashlar post to retain sprung fillet.

Plates 138-139 show the threaded angle above the ceiling, with a spreader in oak inserted below the nut in **Plate 139** where the top surface of the board was considered to be softened with decay.

7.6 HESSIAN

Windows cut in the hessian either for samples sent for testing, or to find screws beneath were made good with sailcloth (code no. 00169/23A manufactured by Richard Hayward & Co.) and attached with Beva 371[46]. Four coats of Beva 371 were first applied to the sailcloth and allowed to dry, then the coated sailcloth was cut into patches to fix over the windows in the hessian and adhered using a heated spatula or domestic iron at on a low setting. Prior to fixing, the area to be covered was first given a coat of Beva 371 and allowed to dry. **Plate 143** shows the sailcloth being applied and **Plate 144** shows the area between joists 14-18 in column III after all patches had been applied Where the hessian was pierced by the actual size of the screw head, and as the new screws are stainless steel, it was felt that there was both little to be gained by covering them with sailcloth, but there would be a positive benefit by leaving the heads exposed, so that at least these screws could be easily be found in the future. The position of all new sailcloth patches is recorded on **Graphic 8**.

[46] Beva 371 is a heat seal adhesive developed by GA Berger in 1970.

7.7 CONSOLIDATION OF FRAGILE AREAS OF DECAY

7.7.1 Paraloid B72

To prevent further wood loss from small areas of boarding that were unstable due to decay or infestation, exposed wood was consolidated with infusions of Paraloid B72 (10% in xylene) (see **Graphics 7A/B**)

7.7.2 Bencon 19 Epoxy Resin

No consolidation with this epoxy was required in this Phase.

7.8 FILLINGS

As an added precaution against loss of both wood and overlying paint, following consolidation treatment, a filler was inserted to secure vulnerable edges. The filler consisted of: 1 part Polyfilla, 1.5 parts fine oak dust, 1 part Plextol B500 (10% solution). See **Plate 147** (see **Graphics 7A/B**).

7.9 SPLITS

Splits were injected with Plextol B500 by hypodermic syringe. Where the fragment to be glued was loose, wedges were temporarily driven to hold the joint together as the glue cured[47] (see **Graphics 7A/B**).

7.10 RE-INTEGRATION WITH TIMBER INSERTS

It was felt that some lacunae would be sufficiently visible and distracting from the floor, that they should be made good. No attempt would be made to disguise the timber inserts, but equally the re-integration would not be artificially visible. Four areas were selected in *Panels 33 II, 31 I,* and *29 II*(see **Graphics 7A/B**).

Panel 33 II

Plates 148-154 show the entire sequence for this repair. Each board is fixed with stainless steel screws to the softwood patch above, behind the overlap of the succeeding board. The final board seen in **Plate 152** was screwed from above, also with a stainless steel screw and washer at its south end which also supports the fragment of original board. In **Plate 150** Bob Chappell is seen planing a board preparatory to fixing it in the ceiling. **Plate 153** shows the completed patch painted with A white acrylic-based primer with initial applications of differently toned, acrylic-based glazes.

Panel 31 I

Plates 155-157 show the repair before, during and after completion. Note in **Plate 156** that the added patch is screwed from beneath through the existing hole that can be seen in **Plate 155**. The actual screw is hidden by an oak pellet. A white acrylic-based primer was applied to all new wood patches followed by numerous applications of differently

[47] Photographic record required in Phase 3

toned, acrylic-based glazes with a matting agent included to prevent excessive shine. No attempt was made to recreate figurative detail

Panel 29 II

Plates 158-160 show two reintegrated areas, one at the end of board (g), the other being the replacement of board (n). The insert to board (g) was fitted behind the scarf of this board and screwed with a stainless steel screw and washer through the existing screw hole in board (g), see **Plate 159**. The replacement board (n) was fixed with stainless steel screws from above.

PART 8: TECHNICAL SURVEY: THE PAINTED DECORATION

8.1 PAINT SAMPLE ANALYSIS

Throughout this project it has been necessary to rely heavily on the analysis of paint samples for answers to queries arising from on-site examinations and treatment tests. There is no record at all of the original painted scheme and little detail of subsequent restorations.

In 1995 paint samples were taken from the Eastern Bay and examined as part of the survey conducted by Hirst Conservation[48]. In 1996, Gillian Lewis obtained a number of paint samples during the inspection of the entire Nave Ceiling from a mechanical hoist: these were examined and analysed by Lewis and Howard. In 1997, as part of the emergency treatment phase, Helen Howard and Adrian Heritage conducted a technical study of the paint layer[49]. Howard obtained an additional 16 paint samples from Bay 1at the start of Phase 1 in 1998[50].

A written paint sampling strategy was prepared during the first three weeks of the Phase 2 on-site works and presented to Ioanna Kakoulli prior to her visit in week 4. Ioanna was not able to obtain all suggested paint samples in one day so made a second visit during week 10. A revised strategy was prepared for this second visit. The sampling strategies form an important record of our developing understanding of the Ceiling as the work progresses. They are included in this report as **Appendices 7 and 8.**

The Phase 2 analysis concentrated on the lozenge border decorations and the frieze pattern on the Ashlar boards. The detailed results are set out in *Peterborough Cathedral Nave Ceiling Paintings: Scientific Examination Phase 2* Dr Ioanna Kakoulli, December 1999. The implications of Howard's (1997/8) and Kakoulli's findings are discussed in following sections of this report.

[48] *Nave Ceiling Peterborough Cathedral* Hirst Conservation, October 1995.
[49] *Peterborough Cathedral, Nave Ceiling: Scientific examination of the original decoration*. Helen Howard, Sept.1997.
[50] *Peterborough Cathedral: Nave Ceiling. Scientific examination of the original decoration of bays .36-39.* Helen Howard, 1998.

8.2 THE ORIGINAL SCHEME

A detailed graphic record of all underpaint visible in low –relief below the present scheme was drawn up as part of the Phase 2 condition survey. In Phase 1 underpaint on the ceiling boards was categorised in the written board by board survey and denoted with a symbol on the graphic record where it exists on the lozenge border pattern boards. Only the underpaint on the Ashlar boards was drawn up accurately in Phase 1. A number of important observations have been made as a result of this exercise.

8.2.1 Central Lozenge Boards

Generally the 1740s and 1830s restorers followed closely the original foliate and figurative designs on the central boards of the lozenges (see **Plates 396, 398, 399**). The sole exception identified to date being the Dragon lozenge detailed in **Plate 397**. Here raking light defines the head and neck of a Renard in low relief beneath the overpaint. It occupies only one quarter *(33 III)* of the lozenge. The shape of the Renard is outlined in **Figure 7**. Not enough low relief underpaint survives within the other three quarters of this lozenge to suggest the original subject.

In Phase 2 eight paint samples were obtained from the central boards of the lozenges and analysed by Kakoulli. Original paint was identified in three of the samples: deep red ochre and charcoal black[51]; a deep red haematite-rich ochre over a reddish orange layer[52]; charcoal black[53]. In contrast to the findings of analysis carried out in 1997 and 1998 on samples from central lozenge boards where original paint exists Kakoulli found no evidence of an intermediate preparatory layer at the interface of the wood and paint layer. The effects of subsequent interventions have so far made it impossible to determine this aspect of the original technique with any certainty.

8.2.2 Lozenge Border Patterns

The original lozenge border designs differed significantly from their present appearance. During Phase 1 it was noted that a trefoil pattern terminating in an elaborate scroll design existed under the extended chevron pattern on many original oak boards. Other examples of underpaint showing the outlines of border designs in relief on boards with otherwise 'weathered' surfaces were also noted. In Phase 2, as a consequence of the detailed examination required to accurately record the visible underpaint and with the results or extensive paint sample analysis we have a greater understanding of how the essentially linear border designs evolved through at least two restorations. **Figure 16** (see page 60) is a reconstruction of what is now consider to be the 13th century lozenge border decoration; although, further investigations are required to confirm this interpretation. Starting from the outside the original decorative pattern sequence was as follows:

- The base boards filling the space between the diamond-shaped compartments had a black scroll design with trefoil ornament. This observation has not been substantiated by sample analysis[54].

[51] Kakoulli 1999: Sample 14
[52] Kakoulli 1999: Sample 44
[53] Kakoulli 1999: Sample 20
[54] For inclusion in list of samples for Phase 3

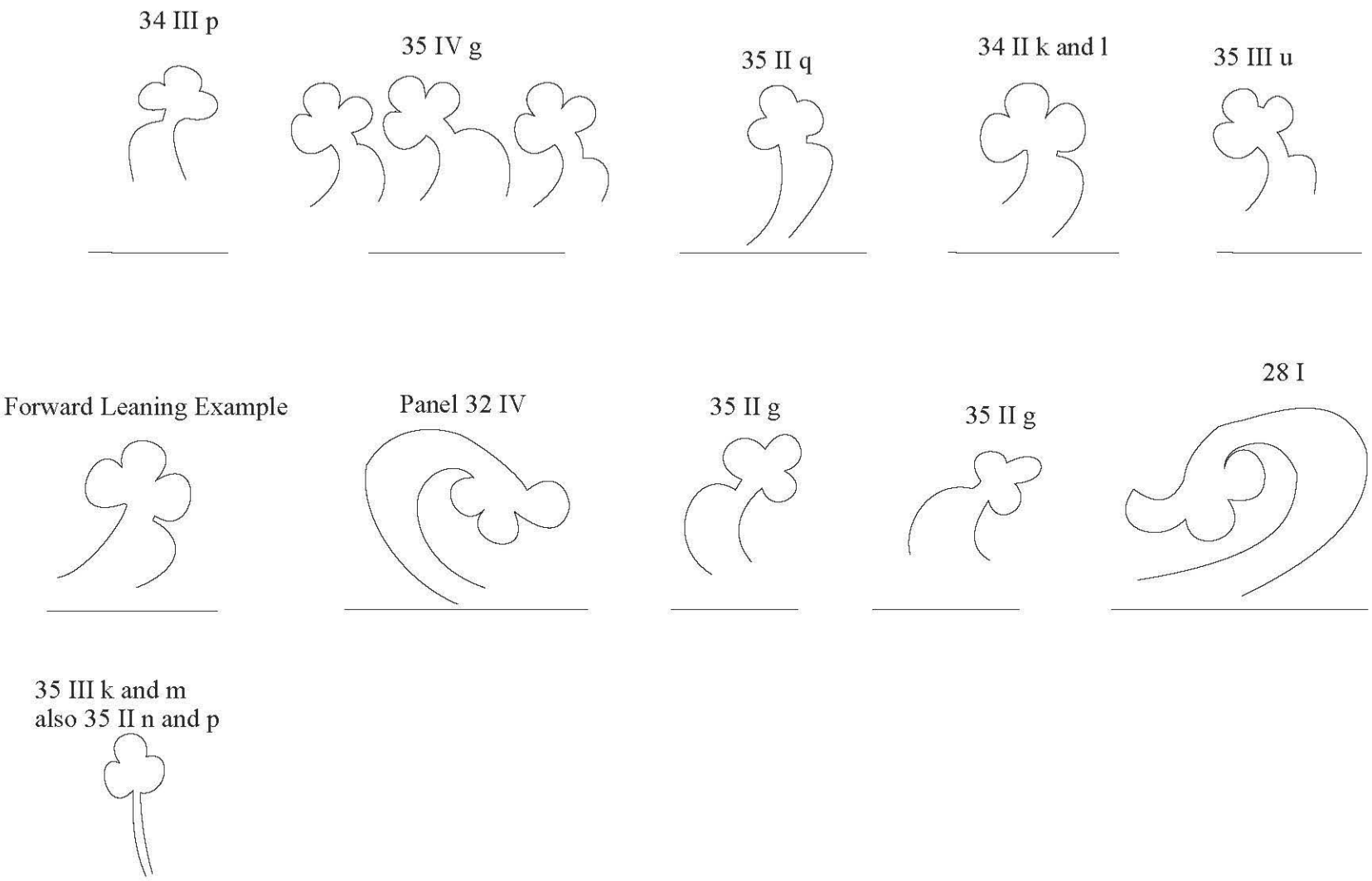


Figure 14. *Tracings of typical trefoil shape (Scale 5:1).*

- A grooved board with the alternating red (red and white lead)[55] and black bands intersected at the corners by an elaborate black scroll with trefoil ornament. No pigment was found on the sample taken to identify the black paint[56].

- A series of regularly spaced black (carbon black)[57] trefoil motifs springing from a black band along the inner edge of the board. At each corner a black elaborate scroll extends onto the outer coloured bands board. This pattern is mirrored in the opposite quarter of the lozenge so that the trefoil motifs spring out towards the extended corners forming an impression of crocketed gables. The trefoil motifs vary considerably in shape - in some cases even along one board. Examples of the different shapes found within Bays 2 and 3 were traced and are reproduced at smaller scale in **Figure 14**.

- A grooved board with the alternating red and black bands[58].

- A linear stepped chevron design in black. This observation has not been substantiated by sample analysis[59].

- A linear wave pattern in red with scrolled ends[60] (see low relief in **Plate 392**). On the smaller, half-lozenges immediately over the Ashlar boards the wave pattern is substituted with linear keyhole (see low relief in **Plate 393**) and dog-tooth patterns: the linear keyhole in black (charcoal black)[61]; no original paint was identified in the sample taken to identify the black in the linear dogstooth sample[62] so the pigment has yet to be identified.

- A grooved board with the alternating red and black bands.

This hypothesis helps to explain the curious ship-lapped sequence of grooved, straight edged and curved edged boards. Each of the three grooved boards in the sequence were probably painted with alternating red and black bands within the grooves. The existence of the shallow grooves, which are certainly not visible from any distance, may be explained as a guide for the painting of these coloured bands. The straight edges on the grooved and stepped chevron boards mark the division between tiers of decoration and help to create an illusion of depth. The shallow curved edges of the central boards minimises the impact of the ship-lap construction on the figurative decoration. Similarly, the slightly steeper curved edges of the linear, stepped chevron and trefoil pattern boards act to reduce the appearance of a division between patterns on the same 'tier'.

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[55] Kakoulli 1999: Sample 26

[56] Kakoulli 1999: Sample 27. Further sample required in Phase 3. . Kakoulli 1999: Sample 37 - original charcoal black found within groove on grey chevron board.

[57] Kakoulli 1999: Samples 16 and 39(?). Howard 1997:Sample 27 (white lead with vermilion inclusions as underpaint). Further sampling is required in Phase 3 to resolve this conflict of evidence.

[58] Kakoulli 1999: Samples 37, 57. No original paint was found in Sample 57. In Phase 3 we will look for more evidence of original paint within the grooves, particularly where the surface has been protected from overpaint by original nail heads (now missing).

[59] Howard 1997: Sample 17. Kakoulli 1999: Samples 32. No evidence of original paint was found in these samples. Further sample required in Phase 3.

[60] Kakoulli 1999: Sample 18

[61] Kakoulli 1999: Sample 19

[62] Howard 1998: Sample 6. Further sample required in Phase 3.

Kakoulli found that most of the original paint examined in Phase 2 had been applied directly onto the ceiling boards without an intermediate preparation layer. Only two samples of paint from border decoration on original boards were analysed in 1998[63]: neither showed evidence of either medieval paint or a preparatory layer. In 1997, of the 9 samples[64] obtained from the border decoration, only one (*Sample 27*) had what may be an original paint layer - carbon black directly on the wood support – and none had traces of calcium sulphate at the wood/paint interface.

8.2.3 Low Relief Original 'Underpaint'

Throughout Phase 2 considerable efforts were made to explain the existence in shallow relief of elements of the original scheme beneath 1740s and 1830s paint (see **Plates 382-389 and 392-399**). Visual examination suggests that the relief effect, first thought simply to be the result of impasto underpaint, is in most instances too pronounced for the thickness of surviving original paint to be wholly responsible. This is born out by analysis results from 19 samples obtained from such shallow relief during this project. In many cases no original paint exists in the cross sections and where it is present the layer/s are thin.

The shallow relief appears and fades along the boards with no trace of the jagged, stepped edges that would signify flaking and loss of a paint layer. The fact that this relief decoration is so intermittent suggests shallow carving did not create it. In addition, there are numerous instances where the shallow relief intersects and is level with a prominent medullary ray (see **Plate 382**). This suggests the softer wood between the rays has receded through decay where it was not protected by a paint layer. It is inconceivable that a carver would have only carved the lower ground between the medullary rays. **Plates 382-385, 392-394** illustrate the way in which the wood surface around the original trefoil and other border patterns appears to have has receded through decay: the softer part of the growth rings being more affected and resulting in a close-ridged surface. A similar example of prominent painted detail within an apparently receded background was found by the Perry Lithgow Partnership in 1999 on the 15th century Choir Ceiling of St Albans Cathedral (see **Figure 15**).

Analysis has yet to establish whether the background to the Peterborough Nave Ceiling border design was painted or the wood surface left exposed. The results of Phase 2 paint sample analysis indicate that the lozenge border decoration was painted directly onto the oak boards without an intervening preparatory layer. By implication this finding suggests the background to this linear scheme must have been unpainted: otherwise the finely painted border designs would overlay the previously applied background paint.

Plates 396 & 397 show the same close-ridged, receded surface as background to foliate and figurative detail on the central lozenge boards. Analysis by Howard in 1997 and 1998 has shown that original painted detail within the central lozenge boards is over an oil-bound white lead ground. If the receded background proves to be the result of some fungal or chemical decay mechanism affecting the unpainted wood surface then the evidence in these photographs would suggest that the white lead ground and original paint did not extend overall the central lozenge boards.

[63] Howard 1998: Samples 5 and 6
[64] Howard 1997: Samples 13, 17, 18, 19, 25, 26, 27, 28, 29

Heraldic scheme: oil paint on oak boards restored/overpainted in the C19th.

Figure 15. *St Albans Cathedral, C15th Choir Ceiling: Detail showing the apparently receded wood surface where original background paint had been lost. The same phenomenon has occurred on the nave ceiling at Peterborough Cathedral.*

8.2.4 Setting Out Lines

A number of carpenter's marks and alignment grooves were found across the central boards of some lozenges (see **Plates 37, 38, 39**). Generally these marks still line up. These incision lines are thought to be original since in most instances the boards have original nails in place so could not have been repositioned. If original their purpose is unclear since the lozenge design and ship-lap construction dictate the position of each board: the alignment marks would seem superfluous. It they served as reference marks to align the painted decoration it would imply that some of the painted decoration was set out on the boards before the boards were put in place. This must be considered unlikely – except in the case of the coloured bands decoration in the grooves – as it would be extremely difficult to lay out the ship-lap construction accurately on the ground or on the scaffold.

To date we have found only one example of incision lines used to set out a painted design on this ceiling. Tram lines have been scored around St. Peter in the shape of a mandorla (**Graphic 1**). The lines are about 5cm apart, and have been made with a sharp implement.

8.3. PREVIOUS INTERVENTIONS

There is documentary evidence that the painted scheme was restored between 1740 and 1750 and again in 1830s. There are no detailed records of these restorations; although, it is clear that repainting on both occasions was extensive and inept. It is not known if there were significant interventions to the painted decoration prior to 1740; however, it would be remarkable had nothing at all been done to the scheme during the intervening 500 years. Some structural alterations would have been made to the east end of the Ceiling when he tower arch was remodelled in the 14th-century; subsequent structural intervention when the tower wall was rebuilt in the 1880s has confused indications of previous works. In the absence of evidence to the contrary this survey assumes the earliest repaint to date from the 1740s.

8.3.1 The 1740s Restoration

Cave[65] states that In 1789 Govenor Pownall wrote of a meeting in 1773 between the then Bishop of Peterborough and the restorer (still living some 30 years later). The Bishop recalled he '*learnt from him that the whole was repainted in oil. He told his lordship that several of the figures were entirely encrusted with dirt, but that upon applying a sponge they became clear and bright, but whence he concludes that the last coat was oil. He was altogether of the same opinion with what 1 had suggested, that the body of the painting (under what he supposed to be the coat of oil) was in distemper: parts came clear off from the wainscot. He assured his Lordship that he only retraced the figures, except in one instance the third or fourth compartment from the West door, where the whole figure peeled off. in this single instance he followed his own fancy…*'

Plates 401-405 depict examples of the 1740s paint layer exposed from under temporarily removed 1830s Ceiling bolts and washers. The 1740s paint has been protected from subsequent overpaint and surface accretions. These examples indicate the condition of the painted decoration immediately prior to the 1830s intervention and provide visible confirmation of the analysis findings and our interpretation of the conservation history.

[65] *Archaeologia LXXXVII* 'The Painted Ceiling in the Nave of Peterborough Cathedral' Cave and Borenius 1938.

Figure 16. *Reconstruction of probable original medieval lozenge border decorations.*

Figure 17. *Reconstruction of probable lozenge border decorations as painted in the 1740s.*

Figure 18. *Lozenge border decorations as painted in the 1830s.*

8.3.1.1 Lozenge border patterns – Analysis of a limited number of paint samples, obtained during the Emergency phase and Phase 1, from boards with the lozenge border designs led us to assume all these boards had been entirely repainted in the 1740s. Kakoulli's 1999 findings and subsequent visual observation indicate this assumption was incorrect. **Figure 17** is a reconstruction of what we now consider to be the 1740s lozenge border decoration. Starting from the outside the 1740s decorative pattern sequence was as follows:

- The base boards filling the space between the diamond-shaped compartments were coated with very characteristic brown/black paint over a white lead ground[66]. The scroll design with trefoil ornament was painted white (this observation has not been substantiated by sample analysis)[67].

- A grooved board with the alternating red and black bands intersected at the corners by an elaborate black scroll with trefoil ornament. This board was not repainted in the 1740s.

- A series of regularly spaced black trefoil motifs springing from black band along the inner edge of the board. At each corner a black elaborate scroll extends onto the outer coloured bands board. This board was not repainted in the 1740s.

- This grooved board was painted with the grey chevron pattern over a brown/black ground[68]. The white embellishments on the grey chevron design varied considerable within Bay 1 and the east half of Bay 2 (*Rows 39-33)*. From *Row 32* westwards the embellishment becomes more formalised as a small V shaped 'leaf' motif (white lead with a little carbon black)[69] (see examples in **Plates 166, 167**).

- The original linear stepped chevron design was completely overpainted with a brown/black stepped chevron design over a lead white ground[70].

- A linear wave pattern in red with scrolled ends This board was not repainted in the 1740s: neither were the keyhole and dogstooth patterns on the smaller, half-lozenges immediately over the Ashlar boards.

- This inner grooved board was repainted with a Greek key pattern in brown/black over a lead white ground[71].

[66] Kakoulli 1999: Sample 17
[67] For inclusion in list of samples for Phase 3.
[68] Howard 1997: Sample 28. Howard 1998: Sample 5. Kakoulli 1999: Sample 47
[69] Howard 1997: Sample 28
[70] Howard 1997: Sample 17. Kakoulli 1999: Sample 30
[71] Howard 1997: Samples 13, 25. Kakoulli 1999: Sample 13

8.3.1.2 Central lozenge boards - Analysis of samples obtained from the central lozenge boards in Phase 2 generally confirm Howard's findings in 1997/8. The 1740s restorer did not apply a preparatory ground overall the figurative and foliate panels prior to repainting. Much of the 1740s decoration is directly over the original paint layer. Where a plain white lead layer underlies the 1740s paint it is not always clear whether it is original or a 1740s ground. In addition to the brown/black composite paint, a red paint (red ferric oxide with red lead inclusions)[72] and an olive green copper-bearing pigment mixed with ferric oxide particles[73] were identified as belonging to this restoration.

8.3.1.3 Replacement boards - The characteristic thick brown/black 1740s paint (see **Plates 496, 497, 499**) – a composite of large charcoal black particles, ferric hydroxide and lead white – can be identified with ease in magnified sample cross-sections and with the naked eye from the scaffold. It has been observed on a limited number of softwood replacement boards allowing us to distinguish these from the 1830s replacements. We have yet to find other reliable features that are visible from the scaffold to distinguish softwood boards from different interventions. In Bays 2 and 3 only twelve softwood boards have been recorded as 1740s replacements. For the time being this should be considered a minimum figure.

Genus analysis carried out by Cathy Groves of Sheffield Dendrochronology Laboratory, University of Sheffield[74], identified (from 19 samples taken) two different coniferous wood types in Bays 2 and 3. Only one sample was taken from a softwood board that had been considered - from observation of the paint - to date from the 1740s intervention[75]. This board is from the Type A (*Pinus sylvestris* group). The fourteen other Type A boards were considered through observation of the paint to be 1830s. This suggests either that the board dates from the 1830s, in which case dating the boards through observation of the paint is unreliable, or that the same wood type was used in both interventions.

It is interesting to note that the 4 samples of Type B (*Picea/Larix* group) wood are from the 4 easternmost boards sampled[76]. This may have some significance and is discussed further in Item 8.3.2.4 of this report.

8.3.1.4 Ashlar boards – The Ashlar boards (probably referred to by the 1740s restorer as the *'wainscot'*) may have been replaced at this time and painted with a scheme very similar to the existing 1830s frieze decoration (described in Item 8.3.2 of this report). This possibility is based on the hypothesis that the softwood replacement ceiling boards with frieze underpaint (see **Plates 435-438**) are 1740s Ashlar boards, salvaged in the 1830s, and re-used as ceiling boards. Eight of these boards were identified in Bays 2 and 3 and seven in Bay 1. At present we have no other explanation for the existence of softwood ceiling boards with frieze decoration underpaint; although, even this theory may be proved incorrect.

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[72] Kakoulli 1999: Sample 55

[73] Kakoulli 1999: Samples 15 and 29

[74] *Tree-Ring Analysis of Timbers from Peterborough Cathedral, Peterborough, Cambridgeshire: Boards from the Painted Nave Ceiling - Phase 2*. Cathy Groves March 2000.

[75] Board Ref. *31 IV l*

[76] Groves, March 2000: Figure 5

Towards the end of the Phase 2 on-site works, we found that the frieze decoration on one replacement ceiling board appears to be overpainted with the 1740s composite black paint[77] (see **Plates 436-438**). We envisage analysis of these samples will also help to date the frieze decoration underpaint. If barium sulphate is identified in this layer the underpaint could not be from the 1740s restoration. Barium sulphate (barium white , or barytes) came into use as a pigment only towards the end of the 18th century[78]. Analysis of samples obtained in Phase 2 from a similar board with the frieze decoration underpaint was inconclusive[79].

8.3.2 The 1830s Restoration

In Phase 2 we have made significant progress in determining the full extent of this major intervention to the structure and painted decoration.

8.3.2.1 Technique and materials - The inclusion of barium sulphate as a component of some paints provides a useful *terminus post quem* of the end of the 18th century. In the absence of any evidence to suggest more than two significant interventions to the paint layer - the 1740s being the first – paints containing barium sulphate must belong to this restoration. However it is important to note that not all the 1830s paint has the barium sulphate extender: so while its inclusion indicates 1830s paint, its absence does not necessarily imply the paint is from the 1740s or the original scheme. The inclusion of barium sulphate as an extender in the 1830s white lead paint appears to have been entirely arbitrary.

The 1830s restorers used a variety of white paints. Lead white with and without the inclusion of barium sulphate as well as with dispersed particles of red yellow and black has been identified. These additions cause the white paint to fluoresce differently under UV illumination (see **Plates 413 and 417**) thus confusing on-site investigations.

Similarly, observations from the scaffold indicated the 1830s restorers had used a wide variety of black paints. Considerable effort was made to categorise these blacks and identify examples for inclusion in the Phase 2 sample strategy. Analysis has identified 4 categories of black: a composite black; a pure black; a charcoal black mixed with lead white; a resinous black [80]. Perceived variations within these categories result from slight differences in the pigment mix, the ratio of medium to pigment, the application of one black paint over another and the thickness of the layer. Observation from the scaffold and the analysis results suggest that the composite black category was used to strengthen or overpaint the 1740s brown/black while the charcoal black mixed with white lead was used mainly for the extended chevron and wave pattern decoration. To date we have no explanation for the seemingly arbitrary use of the very resinous black paint and what appears to be more of a varnish coating with some black pigment inclusions that has been applied carelessly over other 1830s black paint (see **Plates 425-428**)[81].

8.3.2.2 Lozenge border patterns – **Figure 18** is a reconstruction of the lozenge border decoration as painted in the 1830s and therefore as it appears now. Starting from the outside the 1830s decorative pattern sequence is as follows:

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[77] This observation will be tested in Phase 3 by analysis of samples taken from this board at the end of the Phase 2 works.
[78] Kakoulli 1999, (Item 4.1, page 11).
[79] Kakoulli 1999: Samples 1 and 2
[80] Kakoulli 1999, Table 4 (pages 16/17)
[81] Kakoulli 1999: Sample 45

- On the base boards the 1740s brown/black paint was 'strengthened' but not entirely overpainted with a black pigment consisting of a mixture of lead white, barium white, ferric oxides and hydroxides and charcoal black[82]. Generally the 1830s restorers made an effort to retain or simulate the brown/black colour of the 1740s scheme on the base boards, grey chevron, stepped chevron and key pattern boards. The scroll design with trefoil ornament was overpainted in white lead – this observation results from inspections in normal light and under ultraviolet (UV) illumination but has not been substantiated by sample analysis. UV light enhances the differences between the paints from each restoration, particularly whites (see **Plates 413, 417**).

- The grooved, coloured bands board, seemingly untouched in the 1740s, was entirely repainted in the 1830s. Two coloured bands, black (charcoal)[83] and red (red lead mixed with white lead)[84] over a lead white ground, occupy the outer half, a grey/brown thinly applied wash[85] - usually over a white lead ground but occasionally directly onto the wood support – covers the inner half of this board.

- The original trefoil pattern was entirely overpainted with a white lead ground and replaced by a black (charcoal black with white lead and barium sulphate inclusions)[86] extended chevron pattern. An additional feature to the decorative scheme, identified during Phase 2, is that the centre of some trefoils are embellished by a raised dot **(**see **Plate 385)**. The dots have a grainy texture and surface microflaking. Although at first thought to be part of the original design, sample analysis indicates the embellishments are simply white lead with barium sulphate inclusions[87]. These embellishments are prevalent on trefoils in *Panels 35-32 II and 29 II* and appear sporadically in *Rows I and III* across Bays 2 and 3. Because the granular texture of these dots is so distinctive and unlike and other material added in the 1740s and 1830s interventions it would be worthwhile obtaining another sample if these embellishments are found in future phases[88].

- The 1740s grey chevron pattern from *Rows 39-32* was untouched by this restoration except for some strengthening of the brown/black paint as with the base boards. From *Row 33* onwards the grey chevrons white edging and V shaped 'leaf' motif were entirely overpainted and replaced with a lighter grey (carbon black/lead white with some red, yellow and brown oxide particles)[89] chevron with white edging and a white motif of graduated brush strokes (see **Plates 429, 430**).

- The 1740s white ground on the stepped chevron pattern board was overpainted with white lead paint[90] (see **Plates 412, 413**): the white paint was carelessly applied and

[82] Kakoulli 1999: Sample 17
[83] Kakoulli 1999: Sample 35
[84] Kakoulli 1999: Sample 36
[85] To date there has been no analysis of this paint. For inclusion in list of samples for Phase 3.
[86] Kakoulli 1999: Sample 10
[87] Kakoulli 1999: Sample 8
[88] For inclusion in list of samples for Phase 3.
[89] Howard 1997: Sample 28
[90] Kakoulli 1999: Sample31

generally overlapped the brown/black stepped chevron pattern. The edges and where necessary other parts of the brown/black stepped chevron pattern were strengthened with a brownish matrix of brown and yellow iron oxide particles combined with brilliant yellow and black[91]. On the 1830s softwood replacement boards the black chevron pattern (a brownish matrix of charcoal black, dispersed red ferric oxides, yellow ferric hydroxides, lead white and barium sulphate) covers a lead white ground[92].

- It has proved particularly difficult to determine the sequence of interventions to the wave pattern boards. Observations from the scaffold and analysis of paint samples have provided conflicting evidence. Either treatment and repainting of these boards in the 1830s was inconsistent or, contrary to our current interpretation, the original linear wave decoration was overpainted in the 1740s. Observation from the scaffold indicates generally that the black 1830s paint is directly over the wood. The lack of an intermediate ground layer may account for damage to the paint– in the form of microflaking– associated with the very matt black paint on wave pattern boards only (see **Plate 424**). The pattern of damage in this photograph suggests the 1830s white lead background paint on the outer part of the board was applied up to but not beyond the original linear wave pattern. The black wave pattern was then applied, but – as the 1830s wave pattern does not follow exactly the linear original – the black paint often overlaps the white lead background.

  Two samples were taken from the wave pattern decoration on original boards in Phase 2. In one the 1830s black paint is directly on the wood[93], in the other there is an intermediate white lead ground[94]. The latter sample was taken from reasonably near the edge of a black 'wave' so an overlap (as described above) could account for the presence of white ground. Another sample, taken from an original wave pattern board in 1997, has 4 layers of paint: a surface layer of shiny black over a lead white layer; a dense black combined with lead white covering a lead white ground[95]. Both the underlying and surface black paint layers are similar to other blacks associated with the 1830s intervention suggesting the board may have been decorated twice during that intervention.

  In a similar vein, two layers of wave pattern decoration are visible on the slightly displaced original board depicted in **Plate 410**. This finding is an anomaly and may call into question the hypothesis that wave pattern boards were not overpainted in the 1740s. Paint samples were not obtained from this board so we cannot rule out the possibility that the underpaint dates from the 1740s intervention. Analysis of further paint samples from the wave pattern boards should resolve this inconsistency[96].

- The white background to the 1740s key pattern decoration was overpainted in the 1830s. The brown/black key pattern has for the most part been strengthened with a lustrous black layer with red and yellow inclusions[97].

[91] Howard 1997: Sample 17. Kakoulli 1999: Sample 52 (from a 1740s softwood replacement board).
[92] Howard 1997: Sample 18. Kakoulli 1999: Sample 53
[93] Kakoulli 1999: Sample46
[94] Kakoulli 1999: Sample45
[95] Howard 1997: Sample 19
[96] For inclusion in list of samples for Phase 3.
[97] Howard 1997: Samples 13 and 25. Kakoulli 1999: Sample 13

8.3.2.3 Central lozenge boards –The primary purpose of obtaining paint samples from the central lozenge boards in Phase 2 was to provide information on the low relief underpaint. The analysis has confirmed Howard's 1997 and 1998 findings with regard to the 1830s intervention on these boards but has made no significant discoveries.

Generally no preparatory ground was applied over the 1740s paint. 1830s paints identified on central lozenge boards within Bays 2 and 3 include: a brownish matrix of charcoal black, dispersed red ferric oxides, yellow ferric hydroxides, lead white and barium sulphate[98]; a porous red paint consisting of red lead, ferric oxide, lead white and barium white[99]; the same red without barium white[100]; a pink paint of red ochre and lead white[101]; a blue/green paint of pure Prussian blue over a 1740s olive green[102]and a matrix of Prussian blue, white lead and barium sulphate over a white lead layer[103].

It is interesting to note that the 1740s olive green background to the Devil figure (see **Plate 338/9**) and other figurative and foliate lozenges to the east of *Row 34* was not overpainted in the 1830s. From *Row 34* westwards, at least within Bays 2 and 3, the olive green layer (a copper-bearing pigment mixed with yellow ferric oxide particles) has been overpainted with the blue/green paint (Prussian blue or a matrix of Prussian blue, white lead and barium sulphate over a white lead layer).

8.3.2.4 Replacement ceiling boards – The majority of softwood replacements appear to date from this intervention. There is some variation in the type of softwood as well as the size and manufacture of the boards making it difficult to determine the replacement date without reference to the painted decoration. Generally replacement boards that evidently have only one layer of painted decoration[104] and those with two thin layers[105] are considered to be 1830s. Softwood boards with relatively thick underpaint are thought to be from the 1740s[106]. Sample analysis has confirmed these observations. However, it is not always possible to distinguish between the different interventions through observation from the scaffold alone.

The paint on some obviously 1830s softwood boards has a characteristic milky or silvery surface sheen (see **Plate 395, 420**). Analysis indicates this is a thin pale coating as yet unidentified[107]. It does not respond to surface cleaning with Wishab sponges. Also visible on the 1830s softwood replacement board in **Plate 420** is a thin reddish-brown setting out line. Such setting out lines appear to have been used for lining up painted decoration in the few instances where one wide replacement board has been used to replace more than one original board. These lines were not noted in Bay 1.

A small number of 1830s replacement ceiling boards with underpaint in the form of carelessly applied border decoration exist in Bays 1 – 3 (see **Plates 406-408**). No paint samples have been obtained from these examples but the type of board and the quality of the underpaint point to an 1830s date.

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[98] Kakoulli 1999: Samples 34, 55
[99] Kakoulli 1999: Sample 22
[100] Kakoulli 1999: Sample 55
[101] Kakoulli 1999: Sample 44
[102] Kakoulli 1999: Sample 15
[103] Kakoulli 1999: Sample 41
[104] Kakoulli 1999: Samples 49, 53
[105] Kakoulli 1999: Samples 10, 45, 50, 51, 52
[106] Kakoulli 1999: Sample 52
[107] Howard 1997: Sample 18. For inclusion in list of samples for Phase 3.

As discussed in Item 8.3.1.4 of this report the softwood ceiling boards with frieze decoration as underpaint are thought to have been salvaged from the frieze, and re-used on the ceiling, when the Ashlar boards were replaced in the 1830s. This would seem the logical interpretation of evidence to date. The underpaint is unlikely to be 1830s because the 1830s frieze decoration was painted *in situ* so there would be no surplus for use elsewhere. Furthermore, the 1830s Ashlar boards are of tongue and groove design and the ceiling replacement boards with frieze decoration underpaint are not. Should further sample analysis in Phase 3 discover barium sulphate in the underpaint on these boards or find 1740s composite black used as overpaint this aspect of the Ceiling's physical history must be reconsidered.

The results of genus type analysis of samples from 19 softwood replacement boards in Bays 2 and 3 indicate two types of softwood were used: Type A (*Pinus sylvestris* group); Type B (*Picea/Larix* group)[108]. Only 4 of the boards are Type B and these were the easternmost sampled (from *Rows 34 & 33*)[109]. Not enough data is available to draw definite conclusions but it may be significant that in this area of the ceiling a number of differences in the interventions have been noted:

- It is from approximately this point eastwards that the 1740s olive green background to the figurative and foliate lozenges was not overpainted in the 1830s (see Item 8.3.2.3).

- It is from approximately this point eastwards that the 1740s grey chevron pattern is not overpainted except for some strengthening of the brown/black paint as with the base boards(See Item 8.3.2.2). It is also from this point westwards that the 1740s white detailing on the grey chevrons becomes formalised as a V shaped 'leaf' motif.

- The underpaint on the north and south Ashlar boards throughout Bay 1 and the east half of Bay 2 ceases when it reaches in *Row 33* (see Item 8.3.2.5).

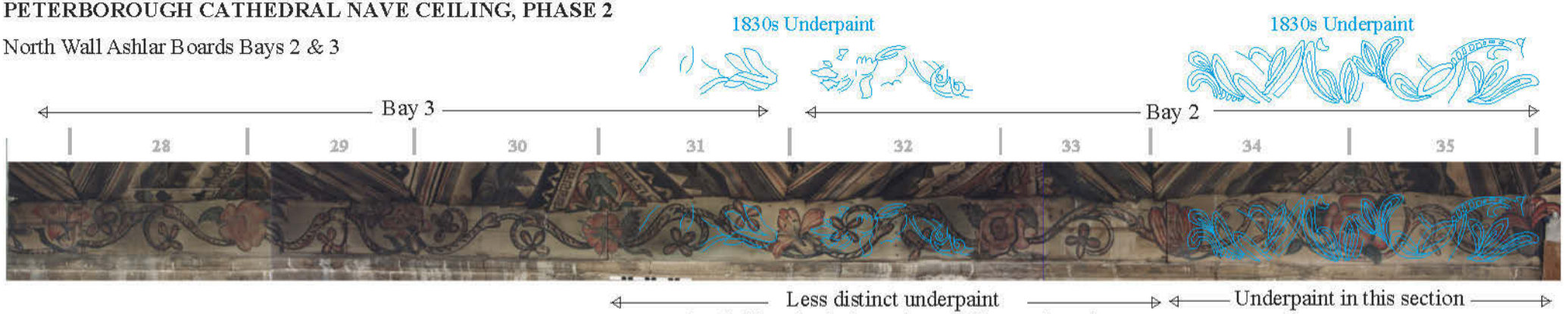
- It is from approximately this point that the nave was screened off during the 1880s rebuilding of the tower wall (see Item 8.3.3 and **Graphic 9A**). In Panels 33 I, II, and III areas of boarding have been screwed into position from below. All these groups of screws are on the line of the screen. The boards cut out to form the patches are characterised by being much dirtier than the surrounding boards and required considerably more effort to clean to the same level as the adjoining boards. See **Plates 210, 211, 206, 207** and **216, 217.** As discussed in Item 3.3.4 of this report, there is no obvious reason for these holes to be cut in the ceiling other than to allow the screen posts to be fixed to the ceiling joists above the ceiling.

- From the point of view of interventions to the structure, significantly fewer screw ends protrude through the ceiling boards to the west of *Rows 33/32* than to the east, while many more clenched nail ends are visible in Bay 3 than in Bay 2.

[108] Groves March 2000.
[109] Groves, March 2000: Figure 5

PETERBOROUGH CATHEDRAL NAVE CEILING, PHASE 2

North Wall Ashlar Boards Bays 2 & 3



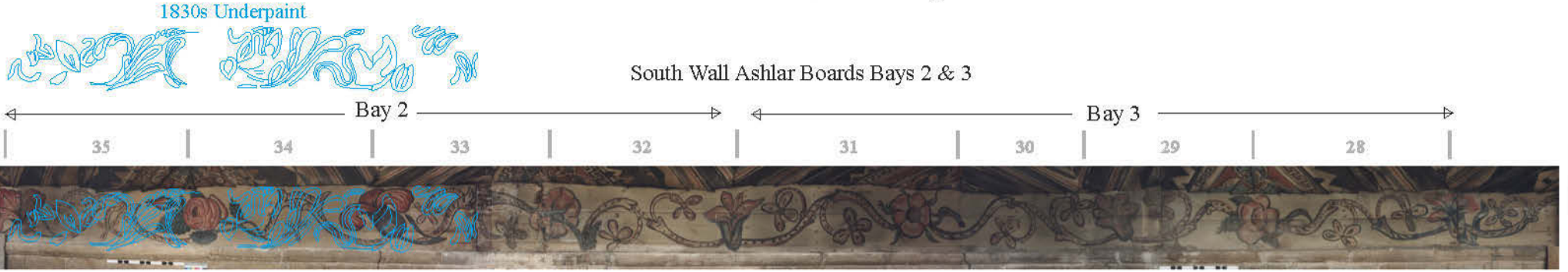
Less distinct underpaint (probable mistake by painters of later scheme) in this section

Underpaint in this section

North side, *Rows 33 to 28* - Similar to *Rows 32 to 28* on the south side although with subtle differences that are difficult define. Probably executed by a different painter::i.e. one restorer painted the south Ashlar boards while another painted the north frieze.

North side, *Rows 33 to 31*- A mistake was painted out with the white background colour while still wet. It is possible to see a misplaced flower through the background. The covering background paint has a distinct greenish tinge suggesting the still wet green paint in the layer below was redistributed in the process.

North side, *Rows 35, 34* - In this section, as well as the whole of Bay 1, the reds and greens are deeper and the blacks more intense. These areas appear to have been painted with more care than what follows to the west.



Underpaint in this section

South side, *Rows 35, 34* and half of *33* - In this section, as well as the whole of Bay 1, the reds and greens are deeper and the blacks more intense. These areas appear to have been painted with more care than what follows to the west.

South side, *Rows 32 to 28* and beyond - The blacks are more resinous in this area and the colours generally less intense. There is more use of brown rather than black in the stem decoration.

Figure 19. *The ashlar boards in Bays 2 and 3.*

8.3.2.5 Frieze decoration on the Ashlar boards – Investigation of the painted decoration on the Ashlar boards in Bay 1 was limited by budgetary constraints. The more complex scrollwork decoration underlying the visible frieze decoration was recorded by Donald Mackreth, the cathedral archaeologist, and reproduced in our Phase 1 report[110] but only one paint sample was analysed[111]. Within Bay 1 an overpainted name and date - W. Stallard 1838(*6?*)[112] - is visible through the covering white ground of the later scheme and the names of I Shaw and C Neal[113], appear on the upper layer. Despite this evidence and other recorded anomalies the underpaint (and therefore the boards) was thought to date from the 1740s intervention. This interpretation has proved false.

Analysis of a paint sample obtained from the north side Ashlar boards of Bay 2 identified barium sulphate as a component of the underpaint: a pink matrix of red, white lead and barium sulphate over two layers of white lead ground[114]. Barium sulphate was not identified in the 3 samples with underpaint obtained from the south Ashlar boards. Notwithstanding, enough evidence has been accumulated about the softwood Ashlar boards and their construction to date them with certainty to the 1830s intervention (see Item 3.3.3.4). In addition, all paint layers in the 8 samples obtained from the Ashlar boards are consistent with the materials and technique of the 1830s intervention to the Ceiling[115]. The following observations regarding the frieze decoration in Bays 2 and 3 were made from the scaffold and are illustrated in **Figure 19** in this report:

- North side, *Rows 35, 34* – Underpaint exists across these *Rows*. In this section, as well as the whole of Bay 1, the reds and greens are deeper and the blacks more intense. These areas appear to have been painted with more care than what follows to the west.

- North side, *Rows 33 to 31* – Less distinct underpaint in this section, probably a mistake by the 1830s restorers. A mistake was painted out with the white background colour while still wet. It is possible to see a misplaced flower through the background. The covering background paint has a distinct greenish tinge suggesting the still wet green paint in the layer below was redistributed in the process.

- North side, *Rows 33 to 28* - Similar to *Rows 33 to 28* on the south side although with subtle differences that are difficult define. Possibly executed by a different painter: i.e. one restorer painted the south Ashlar boards while another painted the north frieze.

- South side, *Rows 35, 34* and half of *33* - Underpaint exists across these *Rows*. In this section, as well as the whole of Bay 1, the reds and greens are deeper and the blacks more intense. These areas appear to have been painted with more care than what follows to the west.

[110] The Perry Lithgow Partnership and Hugh Harrison, January – June 1998, Vol. I: Fig. 7 (p. 48).
[111] Howard 1998: Sample 10
[112] PLP and HH 1998, Vol. II: Plate 306.
[113] PLP and HH 1998, Vol. II: Plate 305.
[114] Kakoulli 1999: Sample 42
[115] Howard 1998: Sample 10. Kakoulli 1999: Samples 3-7, 42, 43.

- South side, *Rows 32 to 28* and beyond - The blacks are more resinous in this area and the colours generally less intense. There is more use of brown rather than black in the stem decoration.

8.3.3 1880s rebuilding of the tower wall

The extent of intervention to the Ceiling boards and paint layer at this time is uncertain. Certainly a number of boards in Bay 1 *Rows 39 and 40* were removed and repositioned and some even replaced. Findings during this phase suggest that the nave was screened off during the rebuilding of the tower in the 1880s (see **Graphic 9a**). A band of thick dirt across the ceiling boards in Bay 2, *Row 32* (see **Plates 439, 440**) coincides with vertical strips of masking tape adhered to the north and south Ashlar boards (see **Plates 441, 442**). Three examples of graffiti written in pencil were found in *Row 33*, immediately to the east of the masked off area. One example (see **Plate 466**) is dated - *Wm George Higgs January 16 1883*. Similar pencilled graffiti was discovered on the ceiling boards in Bay 1, including one dated 1885. No graffiti was found to the west of the dirt band on the ceiling boards; although on the Ashlar boards in Bays 1, 2 and 3 there are a number of examples dated 1890. This graffiti on the Ashlar boards records that limewash was scraped from the nave walls during 1890. As no 1890s graffiti exists above the frieze it is likely that the workers did not have access to the ceiling boards at that time.

The location and text of all graffiti found in Bays 2 and 3 is listed in **Table 3** (Item 8.4.6).

8.3.4 1920s intervention to the structure

In the 1920s a great deal of work was carried out to the Ceiling structure from above (within the roofspace) but there was no access to the Ceiling from below and therefore no alterations to the decoration. The one exception to this may be the unsightly patch repair within the Anthropophagus lozenge (see **Plate 352**). It is possible that the original boards were sawn and the unpainted oak patch was screwed to the transverse softwood boards and lowered into place (see Item 3.3.5.6 of this report).

8.4. CONDITION SURVEY

A board by board detailed condition survey of the painted decoration in the Eastern Bay and Bays 2 and 3 has been recorded on tabulated sheets (see example in **Appendix 3**) and is presented in graphic form in Part 14 of this report. This section defines the categories of damage, surface accretions and other phenomena; most of which are plotted on the graphics.

8.4.1 Flaking Paint (Graphics 10A/B)

The primary cause of flaking paint on the Nave Ceiling is long term water infiltration leading to deterioration of the wood support and subsequent loss of adhesion. We now have a graphic record of all flaking paint within Bays 1, 2 and 3. Paint sample analysis has corroborated some of our observations from the scaffold regarding materials, technique and the extent of each intervention. Not surprisingly, these factors have had a direct bearing on the pattern of flaking paint across the Ceiling. The Bay 1-3 records indicate that the lead white background to the lozenge border patterns is generally stable: as are the paints which overly this layer. The paints susceptible to flaking are:

- The characteristic thick brown/black 1740s paint (see **Plates 495, 496, 497**) – a composite of large charcoal black particles, ferric hydroxide and lead white. This paint has flaked only where it does not overly a white lead ground: i.e. the base, grey chevron and stepped chevron boards. The black/brown paint has tended to delaminate and lift where the wood support has a slightly spongy surface. Where the underlying board has been affected by wet rot the paint surface looks like alligator skin with cracks through the paint layer and associated lifting following the decayed checkerboard structure of the affected wood.

- Where the thinner 1830s velvety black paint of the wave pattern decoration is directly on the wood support without an intervening white lead ground it is susceptible to micro-flaking and loss (**Plate 474**). Similar microflaking occurs on some outline drawing of the figurative and foliate lozenges where the same paint, apparently without an intervening white lead ground, has been used. It is clear that any moisture in the boards resulting from water infiltration was unable to escape through the resistant white lead paint but was able to do so by disrupting this thin black paint layer. This observation is corroborated by the very characteristic efflorescence like a drawn chalk line only found on boards decorated with the wave border pattern[116].

- Within the figurative lozenges the 1740s granular, olive green background paint and the black line drawing are particularly prone to flaking; and the red less so - the detached green paint does not tend to lift and curl as much as the red or black.

- During the Emergency Phase of works in 1997 it was noted that severe flaking had occurred on the flesh tones of St Peter's face, hands and feet and treatment was concentrated in these areas. We have not found a specific reason why the flesh tones on this figure were so affected beyond the possibility that restorers applied thicker paint to these features and that the thickened paint had contracted and lifted away from the support. However, from the information gathered during the Phase 2 condition survey it appears that the painted decoration on *Panels 30 II & II, 31 II & III* had been particularly badly affected presumably as a result of water infiltration. The St. Peter lozenge lies at the junction of these four panels.

- Nail heads. Many of the metal fixings visible on the underside of the Ceiling have corroded to some degree and caused the overlying paint to flake **(Plates 499 &502)**. The percentage of paint remaining on each nail head is recorded graphically.

- Flaking paint caused by the contraction of overlying glue deposits is described in Item 8.4.7.

8.4.2 Powdering Paint (not shown on graphics)

None found in Bays 2 and 3

8.4.3 Paint loss (not shown on graphics)

Except where the painted decoration is missing due to wood loss (in which case it is recorded under the wood loss category) recording the loss graphically would be difficult

[116] Howard 1998: Sample 9. Kakoulli 1999: Sample 21

and the results inaccurate unless marked on extremely large scale graphics. All significant instances of paint loss since the 1830s repaint are recorded in the tabulated board by board paint survey. Small losses have occurred as a result of flaking paint, impact damage and the insertion of nails and screws during previous interventions.

8.4.4 Pigment/paint alteration (not shown on graphics)

Paint sample analysis by Howard in 1997 identified some evidence of pigment alterations in both the original and later phases of painting. This includes the transformation of natural azurite to copper oxalate[117], which indicates deterioration of the original painting, and which may be partly due to an episode of high humidity at some time in the past. Similarly, the alteration of verdigris to form copper chloride[118]. It seem likely that Silvertown treatment, applied in 1926 as an insecticide, may also be implicated in this alteration, since it would have provided a ready source of chlorides. There is no evidence of paint alteration within the visible 1740s scheme. The patchy white surface accretions associated with the thick resinous 1830s black paint/ coating remain unidentified (see **Plate 429**). These were considered to be some form of microbiological growth (MBG) but analysis by Ridout[119] indicates they are accumulations of irregularly shaped, translucent, plate-like crystals. Further investigations are required to determine whether these crystalline deposits are the result of seepage from the paint layer or a reaction caused by adverse environmental conditions[120].

8.4.5 Surface discoloration (not shown on graphics)

The extent of surface discoloration since the 1830s restoration is indicated by the condition of paint exposed from under temporarily removed 1830s Ceiling bolts and washers (see **Plates 401-405**). The 1740s paint has been protected from subsequent overpaint and surface accretions. These examples indicate the condition of the paint surface immediately prior to the 1830s intervention and provide visible confirmation of the analysis findings and our interpretation of the conservation history. In **Plate 405** it is just possible to see a bright white edge of the 1830s white lead background overpaint where it had been brushed under the rim of a ceiling bolt washer. The yellowed surface discoloration overall the ceiling is likely to have resulted from products of combustion emanating from coke fired boilers. These deposits are not entirely removed by surface cleaning with Wishab sponges.

8.4.6 Graffiti (Graphics 9A/B)

Three examples of graffiti written in pencil were found in *Row 33*, immediately to the east of the masked off area. One example (see **Plate 466**) is dated - *Wm George Higgs January 16 1883*. Similar pencilled graffiti was discovered on the ceiling boards in Bay 1, including one dated 1885. No graffiti was found to the west of the dirt band on the ceiling boards; although on the Ashlar boards in Bays 1, 2 and 3 there are a number of examples dated 1890. This graffiti on the Ashlar boards records that limewash was scraped from the nave walls during 1890. As no 1890s graffiti exists above the frieze it is likely that the workers did not have access to the ceiling boards at that time. By intention the examples of pencilled graffiti were not removed during surface cleaning.

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[117] Howard 1997: Sample 23
[118] Howard 1997: Samples 3, 4, 8
[119] Dr B Ridout. Unpublished letter to J Limentani, 16 June 1999.
[120] For inclusion in list of samples for Phase 3.

Table 3.
Graffiti found in Bays 2 and 3

Panel #	Identification on Graphic	Graffiti Text
33ii	t/1	GILBERT
33ii	u/2	Wm George Higgs January 16 1883
33iv	d	G LIVER ? G DIVER ?
Ash 28 -31/l	1	GEORGE BARBER
Ash 28-31/l	2	BARBER
Ash 28-31/l	3	JAPHERTH ABBOTT AGE 40 1890 HELPED TO SCRAPE THIS CATHEDRAL 1890
Ash 28-31/l	4	GEORGE STAPLETON HELPED TO SCRAPE THIS CATHEDRAL IN 1890
Ash 28-31/l	5	G G
Ash 28-31/l	6	GEORGE STAPLETON
Ash 28-31/l	7	G.W.BLOODWORTH HELPED TO SCRAPE THIS CATHEDRAL IN 1890 AGE 19
Ash 31-28IV	1	BARBER GEORGE
Ash 31-28IV	2	A. WENLOCK WORKED AT THIS CATHEDRAL SCRAPING THE STONEWORK MARCH 1890 AGE 24 YEARS

8.4.7 Glue (Graphics 10A/B)

Liquid glue used in the 1920s as an adhesive for the hessian backing material has in places penetrated between the boards, dried on the painted surface and caused the paint to flake. Ultra-violet light is particularly helpful when checking for glue residue. On the horizontal central panels the glue tended to travel vertically down the edge of a board and drip onto the floor below; often leaving thick, raised droplets over the paint on the edge of a board. Many of these thick droplets have contracted in the dry environment and detached from the surface pulling away the underlying paint (see **Plates 488-491**). On the canted side panels the glue residue is more extensive. On penetrating the boards the glue travelled in rivulets across the canted surface before drying (see **Plates479, 481, 483, 485**). In general, the glue has caused paint flaking only where it has collected in thick droplets or runs (**Plates 476 & 477)**. The white background paint is less liable to flake as a result of surface glue deposits.

Some glue drips have a sugary/crusty texture, possibly resulting from the glue having been altered by the action of another chemical (see **Plate 482**). In Phase 2 a sample of

this 'adulterated' or crystalline glue drip was obtained and subjected to FTIR analysis[121]. This confirmed the presence of animal glue, although a specific type was not identified. FTIR analysis of a sample of hessian and glue considered to date from the 1920s intervention and another of hessian and glue from an earlier intervention produced similar results[122]. Further investigation of the glue is proposed for Phase 3.

8.4.8 Surface Staining (Graphics 10A/B)

All stains on the painted decoration result from liquid material penetrating down between the boards or through cracks in deteriorated boards. Stains found on the paint surface in Bays 1, 2 and 3 fall into three categories:

- Water stains - Where water has run across the paint surface leaving distinctive trails of blanched paint and brown surface deposits. These occur more on the Ashlar boards than on the ceiling panels (see **Plates 459-466**). They are not particularly visible under UV illumination.

- Chemical stains – These have resulted from treatment to the ceiling structure above. For the most part they are brown in colour, although **Plate 467** is an example of a 'clear' stain which has saturated the paint surface without causing undue discoloration. This type of stain has not been analysed. **Plate 468** shows a dark brown stain similar to one sampled 1998: FTIR analysis indicated the presence of shellac[123]. A sample obtained during the Emergency Phase from unstained grey paint on a grey chevron board also indicated the presence of shellac in the upper portion of the paint layer[124]. It is not clear whether the shellac, in that instance, is from an applied coating or an accidental accretion. A lighter brown material has caused the large stain shown in **Plate 471**. Although this type of stain occurs frequently – but on a smaller scale - and has proved difficult to remove, it has not been analysed to date[125]. The other characteristic staining prevalent across Bays 1, 2 and 3 are light brown drips frequently found on the edge of ceiling boards or around holes and splits in the boards (see **Plate 474**). A sample of this material was analysed in Phase 2. Results were inconclusive beyond indicating the substance is organic[126].

- Resin – These occur around knots in the softwood replacement boards (see **Plate 467**). Occasionally, a thick drip of resin has emanated from the knot.

8.4.9 Surface Accretions

8.4.9.1 Efflorescence (**Graphics 10A/B**) - Only two small instances of the characteristic efflorescence (like a drawn chalk line) were recorded in Bays 2 and 3. They are too small to show clearly on the 35:1 scale graphics in **Part 14** of this report. This type of efflorescence is only found on boards decorated with the wave border pattern. The chalk line follows the shape of the decoration and occurs on the white lead background paint; although, it is always associated with microflaking of adjacent, deep velvety black, wave pattern paint (see **Plate 424)**. XRD analysis of a sample obtained from Bay 1 provided a

[121] Kakoulli 1999: Sample 9
[122] Kakoulli 1999: Samples 24, 25
[123] Howard 1998: Sample 11
[124] Howard 1997: Sample 28
[125] For inclusion in list of samples for Phase 3.
[126] For inclusion in list of samples for Phase 3.

clear and strong pattern for ammonium lead sulphate and a little sodium sulphate[127]. A further sample taken from Bay 2 was inconclusive[128]. Another apparent form of efflorescence, also associated only with microflaking on wave pattern boards, takes the form of tiny shiny specks, like faces of tiny crystals. They occur rarely in Bays 2 and 3 but these instances, together with the chalkline efflorescence, are recorded in the tabulated board by board survey of the paint.

NB In the Phase 1 condition survey instances of what we now refer to as 'patchy white deposits' were included in the efflorescence category.

8.4.9.2 Patchy white deposits (**Graphic 12)** - Associated with the thick resinous 1830s black paint/coating remain unidentified (see **Plate 429**). These were considered to be some form of microbiological growth (MBG) but analysis by Ridout[129] indicates they are accumulations of irregularly shaped, translucent, plate-like crystals. As mentioned in Item 8.4.4. further investigations are required to determine whether these crystalline deposits are the result of seepage from the paint layer or a reaction caused by adverse environmental conditions.
NB In the Phase 1 condition survey this deposit/surface accretion was generally classified as a surface bloom and in some instances as efflorescence.

8.4.9.3 Tendril deposits (**Graphic 12)** - These resemble miniature spider web, joining larger elements together (see **Plate 433**). Ridout suggests this type of deposit may have originated through microbiological action: some collapsed strand material was found.

NB Throughout the Phase 1 condition survey this deposit/surface accretion was classified as a MBG.

8.4.9.4 Brown/white spots and blotches (**Graphic 12)** - These accretions are widespread across the Ceiling (see **Plate 434**). Ridout describes them as irregularly shaped, translucent granules. Observations from the scaffold suggest the blotches have a fuzzy edge: under x15 magnification the paint surface does not appear disrupted, but a fine white dust is noticeable within the paint texture. The spots are generally brown and at the centre there appears to be a dark brown particle, like a grain of sand, around it is a lighter brown or off-white halo with a fuzzy edge.

NB Throughout the Phase 1 condition survey this deposit/surface accretion was classified as a MBG.

8.4.9.5 Purple grains – This suspected MBG residue found in Bay 1[130] was not present in Bays 2 and 3.

8.4.9.6 Surface dirt (**Graphic 9a**) - There is a layer of surface dirt overall the painted decoration. A band of thick dirt across the ceiling boards in Bay 2, (*Row 32)* (see **Plates 439, 440**) coincides with vertical strips of masking tape adhered to the north and south Ashlar boards (see **Plates 441, 442**). Findings during this phase suggest that the nave was screened off during the rebuilding of the tower in the 1880s. **Plate 420** depicts loosely adhering dust found where draughts have deposited material. This happens where there

[127] Howard 1998: Sample 9
[128] Kakoulli 1999: Sample 21
[129] Dr B Ridout. Unpublished letter to J Limentani, 16 June 1999.
[130] PLP and HH 1998: Plate 336

are gaps or voids in the ceiling allowing air movement between the nave and the roof space above before the hessian was applied in 1926.

8.4.9.7 Surface Bloom (**Graphic 12**) - Nearly all surface bloom recorded in Phase 2 occurs on 1830s softwood boards. The boards appear to have a coating of white dusty material (see **Plate 408**). The cause of this accretion is unclear. Surface cleaning with Wishab sponges reduces but does not remove entirely this whitish veil covering the paint surface.

PART 9: TREATMENT TESTS: THE PAINTED DECORATION

9.1. PREVIOUS TREATMENT TESTING

Hirst Conservation conducted extensive cleaning trials using solvent solutions: these tests are documented in Hirst Conservation's 1995 report[131].

As part of the Emergency Conservation Treatment Phase in 1997 the Perry Lithgow Partnership carried out an extensive series of tests to determine appropriate techniques, materials and methods of application for the re-attachment of flaking paint, the removal of glue film and surface cleaning. Our report of October 1997 includes detailed records of these trials.

From the analysis, testing and treatment conducted in 1997 the painting was known to be profoundly sensitive to moisture. Traces of calcium sulphate were identified at the wood/paint interface and also at varying concentrations throughout the paint layers. In addition, some 19th-century paint layers were also found to contain high concentrations of both calcium sulphate and clay-rich minerals. The clay-based materials swell readily in the presence of moisture as was demonstrated by the severe blanching of some of the paint following even brief contact with water. This discovery is highly significant and affects all aspects of treatment. Only certain of the nineteenth century paint colours are prone to blanch after contact with water; these are identified in Table 1 below.

Table 4
1997 tests identifying paint layers susceptibility to water-induced blanching

ST PETER	POSITION	EFFECT/BLANCHING
Red drapery	To east of central lozenge etc.	Insignificant
Pink shading on red drapery	To west of left hand	Present when swab used; not present when wiped with damp slurped
Yellow/white highlight on red drapery	Sleeve of left arm	Minor
Flesh tones	Left hand	Minor
Flesh tones	Left foot - after full consolidation	Present

[131] *Peterborough Cathedral. Nave Ceiling Vol.1*. Hirst Conservation (Oct.1995)

Light blue drapery	Over left foot - after full consolidation	Present
Black outlines	Several areas	Insignificant or not present, unless already present
Dark blue drapery	Over left foot - after full consolidation	Insignificant
White/cream	Background to 'patterns'	Insignificant with swab, but present after prolonged treatment
Light blue/green	Background to figure	Insignificant/acceptable; but earlier tests were affected by prolonged heat/moisture
Yellow/brown/white	Hair	Minor; mainly appears on the brown, tho' may simply be cleaner
ST PAUL	**POSITION**	**EFFECT/BLANCHING**
Green	Background to figure, by foot	Minor. Previous tests show it can be removed
Yellow/brown	Drapery by sword handle	Took a long time to dry but no apparent blanching
Light blue	Cusped frame	After full consolidation it was very evident, but only occurred occasionally
White/yellow	Sword - after full consolidation	No obvious blanching
Brown/grey	Hair	Possible blanching- or is it just cleaner?
PSALTERY	**POSITION**	**EFFECT/BLANCHING**
Light green	Background to figure	Minor; previous tests indicate it can be removed
Pale pink/cream	Cusped frame	Minor - acceptable
Red	Background	Minor/insignificant
Grey/brown	Frame of instrument	Present
Blue/green	Repaint on background	Minor
Cream	Background to key pattern	Insignificant

9.2. PHASE 1 TREATMENT TESTS

Visual examination of the painted decoration during the condition survey and analysis of paint samples removed from the Eastern Bay confirmed that the same original and added materials were present[132]. Subsequent treatment tests conducted on *Panel 39 IV* corroborated the 1997 findings.

[132] *Howard 1998*

The methods and materials identified as appropriate in 1997 were re-tested before the start of Phase 1 treatment. Paint on *Panel 39 IV* exhibited typical examples of damage and deterioration so was chosen as a trial area. On completion of the tests the entire panel was treated to a finished level and approved by members of the project team.

9.2.1 Paint Re-attachment

This process was the subject of exhaustive trials in 1997. The methods and materials chosen and used to re-attach flaking paint on the St Peter, St Paul and Psaltery Player lozenges were re-tested successfully on *Panel 39 IV*. The following is a summary of the 1997 test results:

9.2.1.1 Paint relaxation - Preliminary trials with a Preservation Pencil established that moisture was the prime cause of surface blanching. The Preservation Pencil, used with an ultrasonic humidifier, is capable of providing a fine, delicate jet of moisture or dry air from ambient temperature to 100ºC. Blanching depends on the type of moisture output which is controlled by the varied heat and moisture settings, and types of nozzle, available on the Preservation Pencil. Moisture, rather than temperature, causes the nineteenth century paint to blanch. It was found that warm dry air can be used to relax the paint flakes without adverse effect. A satisfactory level of paint relaxation is achieved using the larger nozzle on the Preservation Pencil at 40ºC and on minimum moisture setting - any moisture emitted by the Pencil at this temperature setting evaporates without affecting the paint surface. The nozzle is held close to the surface for 3-5 minutes, depending on the thickness of the paint and the level of distortion. Immediately following this process undiluted industrial methylated spirits (IMS) is injected behind the flake to pre-wet the void. IMS applied in this way does not cause surface blanching or adversely affect the adhesives effectiveness.

9.2.1.2 Adhesives - Trials were conducted using three fixatives - Plextol B500, Paraloid B72 and Isinglass - each known to have good ageing properties and an ability to withstand at least some variation in environmental conditions. The tests were to establish appropriate solution strengths and devise effective methods of application in these circumstances, rather than to test the properties of various fixatives. Plextol B500 was .been identified as the most suitable material for re-adhering paint flakes on the Nave Ceiling. Plextol B500 is an acrylic dispersion and therefore water-based: its stability is good and it has appropriate handling properties. It is now widely used as a paint fixative on both wall paintings and panel paintings. Through testing we were able to identify an efficient method of applying the adhesive and pressing back the flakes which involved minimal contact of moisture with the paint surface. A 15% solution in deionised water is required when re-laying large, distorted flakes where the paint layer is relatively thick; a 5-10% solution is adequate for securing the small thinner flakes. Following paint relaxation and pre-wetting very small droplets of the adhesive solution are injected, through a fine syringe needle, behind an individual paint flake. The flake is then pressed back into place with a small pad of dry cotton wool covered by Japanese tissue. The dry cotton wool immediately absorbs the majority of excess adhesive displaced as the flake is re-laid. The tissue is carefully peeled from the surface after the cotton wool is removed. Cleaning tests established that any residual adhesive on the surface following re-attachment by this method will not significantly impair subsequent removal of surface dirt.

A different method is necessary for re-laying distorted paint flakes underlying thick glue deposits. Glue has to be very soft before the underlying paint flake becomes relaxed

enough to be re-laid. The best results were obtained by carefully dabbing the coated flake with a small piece of sponge to remove as much glue as possible; then - using the same sponge - delicately easing the relaxed flake back into position. Injecting Plextol B500 solution behind such flakes is less successful than relying on residual animal glue alone as the adhesive. There is some risk of failure: if a flake detaches while the glue is being removed, any attempt to re-position it fails because the remaining surface glue sticks to the intervention layer. However, these tests were conducted on very distorted paint flakes: where the paint is only slightly cupped or lifted on one side there is little risk of loss.

9.2.1.3 Flaking paint on nail heads - Flaking and lifting paint on nail heads was found to be brittle; there was no flexibility in the paint. Tests revealed that to secure the flaking paint up to two applications of Paraloid B72 (10% in acetone) had to be applied by syringe. Once the solvent had evaporated a localised heat source (Preservation Pencil) was applied to the flakes relaxing them sufficiently and enabling them to be secured by gently pressing into place with a small spatula. Sufficient B72 was required to allow the flake (sometimes bent back at 90' to the original position) to be eased back into position. Tests indicated that a single application of 10% B72 in acetone would provide an adequate protective coating for unpainted and corroded metal fixings.

9.2.2 Consolidation of the Paint Layer

With the exception of *Panel 40 III*, paint on all boards within the Eastern Bay was adequately bound and required no further consolidation. Much of *Panel 40 III* had a thin and very powdery layer of decoration painted directly onto the softwood boards. Trials were carried out using different dilutions of Paraloid B72 in both xylene and acetone. Paraloid B72 is an ethyl methacraylate co-polymer which through tests has been classed as one of the most stable synthetic resins available to conservators and is a preferred material for this treatment process. The consolidant was applied by brush through Japanese tissue paper: the paper was carefully peeled away from the paint surface immediately after application. A 5% solution of B72 in acetone was identified as the most appropriate solution. Generally the powdery pigment was consolidated adequately after a single application. The process did not darken the paint or result in a shiny surface. It was found that more than one application of a similar strength solution of B72 in xylene was required to achieve the same effect. The less volatile solvent apparently caused the consolidant to penetrate further into the support where it was not required.

9.2.3 Surface Cleaning

Tests in 1997 indicated that a 'dry' method of cleaning using Wishab sponges produced good results[133]. This cleaning technique was preferable for a number of reasons: some solvent-based solutions were ineffective; all proved difficult to control and produced different cleaning levels on the various colours and paints; most caused the paint surface to shine; in addition, much of the paint surface blanched after contact with water. By contrast, cleaning tests with Wishabs demonstrated it was relatively easy to achieve an uniform level of clean; the majority of the paint was stable and withstood the gentle surface abrasion necessary without need for preliminary consolidation; surface dirt could

[133] Wishab sponges are cakes of synthetic rubber granules that collect the dirt and self-abrade when rubbed across a surface.

be removed without causing the paint surface to shine; Wishab cleaning is not thought to deposit significant, potentially harmful residues on the paint surface.

As part of their preliminary technical examination of the paint surface within the Eastern Bay Howard and Heritage tested the effect on the paint surface of cleaning with Wishab sponges[134]. The trials areas were examined on-site using a video microscope and samples were taken for further testing in the laboratory. Results of investigations to determine the presence of residues deposited on the paint surface by Wishabs are not yet available. Other preliminary results indicated:

- In general, an appropriate cleaning level could be achieved using the medium and hard grades of Wishab with minimal damage to the paint surface.
- Variations in texture, colour and the condition of the paint would lead to differences in both *real* and *apparent* cleaning levels unless care is taken to ensure that the white is not cleaned to greater level than other colours that are less easy to clean, and for which such a 'good result' is not possible.

Howard recommends the following procedures for Wishab use on the Nave Ceiling:

- Brush surface with soft sable brush before use of Wishab.
- Use small, shaped piece of the sponge which can be applied to a small area, and with considerably more delicacy than the whole sponge surface.
- Monitor cleaning process by regular checking at magnification (at approx. 8-10x, perhaps with *Binomag*. or similar apparatus).
- Brush off surface with soft brush after application of Wishab to remove any residual particles of the sponge and loosened dirt.

9.2.4 Glue Removal

The techniques identified as most successful during extensive trials in 1997 were re-tested and found to be appropriate for use in Phase 1. The following is a summary of the 1997 test results:

Tests indicated that there is no alternative but to use water to remove the animal glue film. Solvents had no effect; heat, rather than having a softening effect, made the glue brittle and contract further. The glue is more easily removed using warm rather than cold water; although, on vulnerable colours the shorter contact time is not noticeably reflected by a lessening of surface blanch.

It appears that the liquid glue affected some of the paint surface before it dried. In one test area the off-white paint appears cleaner following glue removal than an adjacent area that had not been coated with glue but was intentionally cleaned with a warm water swab for a comparable time as a control.

Where the glue deposits are relatively thin and the underlying paint stable, the glue is best removed using warm water (c.a. 55ºC) on small cotton wool swabs. This method is more precise than using the Preservation Pencil which may affect adjacent non-glue covered areas. For the thick, raised droplets of glue, whether or not the underlying paint is flaking, it is necessary to use the Preservation Pencil on maximum moisture setting at 40ºC and gradually dab the dissolved glue away with a small sponge. Warm water on a

[134] *Peterborough Cathedral Nave Ceiling - Tests to determine the effects of surface cleaning with Wishab* Helen Howard, unpublished notes, 1998.

cotton wool swab does not remove the thick runs or droplets completely, even when applied for a considerable period. Tests have shown that glue removal, using warm water on cotton wool swabs, leaves the treated areas noticeably 'cleaner' than their surroundings and causes some of the paint to blanch. It is necessary to disguise this effect with water-colour paints.

9.2.5 Removal of Surface Staining

The removal of staining was not an objective for Phase 1 treatment. Only during the surface cleaning process did it become evident that some stains were particularly distracting and would be apparent from floor level. In consultation with members of the Project Team a decision was made to remove, reduce or disguise a limited number of stains. Tests revealed the dark brown material could be reduced using acetone swabs; the dark grey stains in the Ashlar boards were removable using deionised water swabs but had the same effect on the underlying paint as glue removal.

9.2.6 Reintegration

As part of the Phase 1 testing on *Panel 38 IV* the Hirst Conservation cleaning tests were reintegrated with water-colour paints to match the surrounding Wishab cleaned paint surface. The 'blanched' or 'cleaner' areas of paint resulting from glue removal on *Panel 38 IV* were similarly treated. As with all other tests conducted as a preliminary to treatment the results were inspected and approved by members of the project team.

9.3. PHASE 2 TREATMENT TESTING

No further structured tests were required as no new treatment materials were used during Phase 2. With the benefit of increasing experience some methods of application and techniques were modified slightly. These modifications are detailed in the following section.

PART 10: TREATMENT: THE PAINTED DECORATION

For most categories the extent and location of treatment is plotted on the graphics in Part 14.

10.1. PAINT RE-ATTACHMENT (Plates 495-502)

All the flaking paint plotted on **Graphics 10A/B** - including flaking paint underlying thick glue deposits (categorised as 'Flaking & Glue') - was re-attached in Phase 1; the methods and materials used were devised to minimise water contact with the paint surface and identified as appropriate through the testing procedure. Where possible the flakes were treated individually; although areas of micro-flaking and some interconnected larger flakes had to be re-laid in groups.

Distorted, thicker paint flakes were relaxed to a point where they could be eased back into place without fracturing. This degree of flexibility was achieved by applying a delicate jet of warm dry air from a Preservation Pencil, set at 40ºC and to minimum moisture output. The nozzle was held close to the surface for up to 5 minutes. During

Phase 2 we found that by adding a percentage Industrial Methylated Spirits (IMS) to the adhesive solution it was usually possible to dispense with the pre-wetting process. Only rarely was it necessary to pre-wet the void behind paint flakes with neat IMS following paint relaxation. The adhesive solution comprised a 5% or 10% solution of Plextol B500 (depending on the distortion and thickness of the paint) in a mixture of deionised water and IMS (85:15 mix) [135]. Small droplets of the solution were injected into the void behind each flake. The flake was then eased back into place with a small pad of dry cotton wool through Japanese tissue: the dry cotton wool absorbing excess adhesive displaced as the flake was pressed back. Preliminary relaxation with the heat source was not always necessary for the less distorted or thinner paint flakes; particularly the 1830s black paint on the wave pattern boards.

Treatment of flaking paint underlying thick glue deposits is addressed in 10.3. below.

In **Graphic 11** the visible nail heads are grouped according to the percentage of paint surviving (100-70%, 70-30%, 30-0%). The groupings do not signify whether or not the remaining paint on each nail is flaking. Recording that information was considered unwarranted given that the same material in the same solution (B72: 10% in acetone) was used both to re-attach flaking paint on nail heads and to coat exposed metal. Flaking paint on the nail heads was brittle: there was no flexibility in the paint. Up to two applications of the B72 solution by syringe were required to secure the flakes; the solvent was allowed to evaporate before the paint was relaxed with warm air from the Preservation Pencil (40ºC) then pressed back into place with a small spatula.

10.2. SURFACE CLEANING (Plates 503-510)

The guidelines recommended by Howard for Wishab use on the Nave Ceiling were followed throughout[136]. Loose surface dust particles were brushed from the surface, using small and very soft brushes; the dust sucked into a vacuum cleaner nozzle held close by. Small, shaped pieces of the Wishab sponge were applied to the paint surface with gentle circular strokes; with constant attention to guard against surface shine as well as disruption of loose paint or raised, granular particles. The particles of Wishab remaining on the surface were removed with a soft brush. This method achieves a satisfactory and uniform level of clean, removing much of the efflorescence and bloom as well as most surface dirt; however, a slight surface discoloration remains. Cleaning with deionised water would remove this surface deposit - as proved by previous tests and the paint surface where glue has been removed - but this is not an appropriate option given the extreme moisture sensitivity of the paint. As it is, the slightly yellowed deposit will serve to isolate the paint from future accretions.

10.3. GLUE REMOVAL (Plates 476-493)

Thin deposits of the glue film were removed by swabbing with warm deionised water. Raised droplets and thick runs overlying flaking paint would not be dissolved completely by this method. It was necessary to use the Preservation Pencil on maximum moisture setting at 40ºC and gradually stroke dissolved glue away with a small sponge. Using the smaller of the two round-ended nozzles confined the spread of the moisture. This

[135] Plextol B500 is a product of Röhm. It is an acrylic dispersion of a thermoplastic acrylic resin its stability is good and it has appropriate handling properties. Plextol B500 is widely used as a paint fixative on both wall paintings and panel paintings.

[136] *Peterborough Cathedral Nave Ceiling - Tests to determine the effects of surface cleaning with Wishab* Helen Howard, unpublished notes, 1998.

advantage is somewhat off-set as the moisture output is considerably reduced, thus slowing the process: the small area of paint surrounding the glue is subjected to less moisture but for a longer period.

Re attaching distorted paint flakes underlying thick glue deposits involves some risk of failure: if a flake detaches while the glue is being removed, any attempt to re-position it fails. A small number of paint flakes were lost during this process but the majority were re-attached successfully. The glue was softened by warm moisture from the Preservation Pencil and, as far as possible, absorbed into a small sponge stroked carefully across the surface. Each paint flake was eased back into place with the sponge once most of its overlying glue had been removed. Residual glue carried behind the flake as a result of the softening process serves as the adhesive.

10.4. REMOVAL OF SURFACE STAINING (Plates 459-473)

The policy adopted for Phase 1 was that stains considered to be particularly distracting and visible from the ground should be removed, reduced or disguised. The same approach to stain removal was adopted for Phase 2. The treated stains are identified on the 15:1 scale graphics (source material). Almost all stains were reduced rather than removed. On the original boards it was possible to reduce the smaller water stains using warm deionised water. Water alone was not effective in reducing the chemical stains or the more extensive water stains. For these a variety of materials or combination of materials were used including: a 2% to 5% solution of ammonium carbonate, IMS, acetone or a mixture of these two solvents (50:50). All categories of stains on the replacement boards were more difficult to reduce. None of the solvents mentioned above were effective in reducing these stains without affecting the paint layer. Cleaning with solvents caused a dark halo to appear around the stain which itself was then difficult to remove. In addition, attempts to remove stains on these boards resulted in a shiny surface.

The method and materials used to remove each stain treated in Phase 2 have been recorded on the hand plotted, 15:1 scale graphics. These graphics are included in the source material for this project.

10.5 CONSOLIDATION OF SURFACE SPLINTERS AND SPLITS (Plates 129-145)

Graphics 7A/B.

Where possible splinters of wood that had been displaced by protruding screw ends were repositioned and adhered with a solution of Plextol B500[137] (diluted 1:1).

Many surface splinters could not be repositioned as the offending protruding screw could not removed. In instances where the splinter was clearly unstable but the protruding screw remained it was necessary to assess whether there would be a benefit in cutting a section from the splinter, so that at least part might be replaced, or whether it would be preferable to stabilise the splinter in its displaced position. Although cutting a splinter results in an inevitable loss of material for larger splinters this was adjudged as warranted.

[137] Plextol B500 is an aqueous dispersion of a thermoplastic acrylic resin. A product of Röhm.

The processes involved in the re-attachment of splinters and detached wood fragments were as follows:

- Remove Dust.
- Pre-wet support and fragment/splinter with IMS.
- Inject or apply the adhesive material to all surfaces to be joined. Solutions of Plextol B500. Generally Plextol B500 (1:1 in water) was sufficient, but more substantial fragments sometimes required the use of neat Plextol B500.
- Allow the adhesive material to become tacky.
- Reposition fragment/splinter and apply pressure. Remove excess adhesive material from surface a.s.a.p. with IMS or acetone.
- Very small fragments can be held in position by hand; larger ones are best held by thin tape strips, wedges or battens. It is important to use an intervention layer e.g. melenex to avoid sticking 'pads' to the surface.
- Remove any excess consolidant that may have squeezed out under pressure.
- .Repeated applications may be necessary.
- Where necessary presses were applied overnight to ensure a firm bond.

Unstable splits in the boards were consolidated in the same manner but required more use of wedges, battens and/or stainless steel fixings to hold the split together until adhesion is achieved.

10.6 CONSOLIDATION OF WOOD LOSS (Plate 147)

Although this aspect of treatment is ostensibly to the structure rather than the paint, the work was carried out by the Perry Lithgow Partnership team since the materials involved could affect the paint layer.

To prevent further wood loss from small areas of boarding that were unstable due to decay or infestation, exposed wood was consolidated with infusions of Paraloid B72[138] (10% in acetone)

As an added precaution against loss of both wood and overlying paint, following consolidation treatment, a filler was inserted to secure vulnerable edges where appropriate. All wood loss fills are identified in **Graphics 7A/B**. The filler consisted of: 1 part Polyfilla, 1.5 parts fine oak dust, 1.5 parts Plextol B500 (10% solution). The filler was applied in thin coats (up to ca. 5 mm) to avoid cracking, gradually building up deeper losses.

10.7 REINTEGRATION (Plates 464-473)

The 'blanched' or 'cleaner' areas of paint resulting from glue or stain removal were toned down with water-colour paints to match the surrounding Wishab cleaned paint. All visible stainless steel fixings inserted during Phase 1 treatment were painted in neutral colours using acrylic-based paints.

[138] Paraloid B72 is an ethyl methacrylate co-polymer. A product of Röhm Hass.

Before treatment 1999

Conjectural reconstruction of missing detail

Figure 20. *Anthropophagus (Lozenge 33/34/ I/II). Conjectural reconstruction of missing figurative detail. The background colours only were recreated on the replacement oak inserts.*

A neutral base coat (acrylic) was applied as a ground to all stainless steel fixings inserted during Phase 2. The fixings were then reintegrated to their surround with suitably coloured acrylic-based paints using a technique that will distinguish them from previous repairs on close inspection. A white acrylic-based primer was applied to the new wood patches followed by numerous applications of differently toned, acrylic-based glazes with a matting agent included to prevent excessive shine. No attempt was made to recreate figurative detail (see **Plate 335**). **Figure 20** shows a conjectural reconstruction of missing figurative detail within the Anthropophagus (Lozenge 33/34/ I/II). In fact, the background colours only were recreated on the replacement oak inserts.

Acrylic-based paints were used to reintegrate the repairs material used to consolidate wood loss. A primer of Plextol B500 (20% solution in water) used in some areas, otherwise 2-3 layers of paint were required to give adequate depth of colour.

10.8 SURFACE COATING (Plates 499-500)

Following the removal of loose rust particles a single coating of 10% B72 in acetone was applied as an isolation layer to all corroded metal exposed as a result of paint loss from metal fixings. No surface coating was applied to the painted decoration on the Ceiling or Ashlar boards.

PART 11: THE NAVE CEILING: INVESTIGATIONS FOR PHASE 3

11.1 PAINT SAMPLE ANALYSIS

11.1.1 The Original Scheme

Figurative and foliate decoration - Further sample analysis where appropriate to increase knowledge of the original figurative and foliate decoration. On-site inspection to discover evidence of surviving original paint and later deviations from the original scheme.

Lozenge border decoration - Further investigations are required to confirm what is now consider to be the 13th century lozenge border decoration (see **Figure 16**). Investigations should include:

- The base boards filling the space between the diamond-shaped compartments had a black scroll design with trefoil ornament. This observation ought to be substantiated by sample analysis.

- Sample analysis of any seemingly original paint protected from overpaint by original nail heads (now missing).

- Further investigations of the receded/decayed wood surface surrounding original paint to include the examination of samples of the receded/decayed wood surface for evidence of fungal attack.

- Test removal of a small section of C18th and C19th overpaint from a lozenge border pattern board?

11.1.2 The 1740s Scheme

Further paint sample analysis to test current theories on the nature of the C18th restoration.

- The base boards filling the space between the diamond-shaped compartments were coated with a very characteristic brown/black paint over a white lead ground. The scroll design with trefoil ornament was painted white (this observation has not been substantiated by sample analysis).

- Underpainted frieze decoration on replacement ceiling boards. Towards the end of the Phase 2 on-site works, we found that the frieze decoration on one replacement ceiling board appears to be overpainted with the 1740s composite black paint (see **Plates 436-438**). We envisage analysis of these samples will also help to date the frieze decoration underpaint. If barium sulphate is identified in this layer the underpaint could not be from the 1740s restoration. Barium sulphate (barium white , or barytes) came into use as a pigment only towards the end of the 18th century. Analysis of samples obtained in Phase 2 from a similar board with the frieze decoration underpaint was inconclusive.

- Suspected 1740s softwood replacements – Further analysis of paint on replacement boards considered, through observations from the scaffold, to be from this intervention. This to determine whether such observations are reliable.

11.1.3 The 1830s Scheme

- Analysis of sample from the grey/brown thinly applied wash - usually over a white lead ground but occasionally directly onto the wood support – covering the inner half of coloured bands boards.

- Analysis of further samples from the black wave pattern boards - The underpaint exposed on the slightly displaced original board depicted in **Plate 410** calls into question the hypothesis that wave pattern boards were not overpainted in the 1740s. Paint samples were not obtained from this board so we cannot rule out the possibility that the underpaint dates from the 1740s intervention.

- Underpainted frieze decoration on replacement ceiling boards - As discussed in Item 8.3.1.4 of this report the softwood ceiling boards with frieze decoration as underpaint are thought to have been salvaged from the frieze, and re-used on the ceiling, when the Ashlar boards were replaced in the 1830s. This would seem the logical interpretation of evidence to date. The underpaint is unlikely to be 1830s because the 1830s frieze decoration was painted *in situ* so there would be no surplus for use elsewhere. Furthermore, the 1830s Ashlar boards are of tongue and groove design and the ceiling replacement boards with frieze decoration underpaint are not. Should further sample analysis in Phase 3 discover barium sulphate in the underpaint on these boards or find 1740s composite black used as overpaint this aspect of the Ceiling's physical history must be reconsidered.

- Embellishments on the original trefoil design - As discussed in Item 8.3.2.2, analysis indicates that the trefoil embellishments found in *Panels 35-32 II and 29 II* and that appear sporadically in *Rows I and III* across Bays 2 and 3 date from the 1830s intervention[139]. Because the granular texture of these dots is so distinctive and unlike and other material added in the 1740s and 1830s interventions it would be worthwhile obtaining another sample if these embellishments are found in future phases.

11.2. Materials and Accretions

- Further examination of crystalline deposits and fungal growth on the paint - Patchy white deposits associated with the thick resinous 1830s black paint/coating remain unidentified. These were considered to be some form of microbiological growth (MBG) but analysis by Ridout indicates they are accumulations of irregularly shaped, translucent, plate-like crystals. Further investigations are required to determine whether these crystalline deposits are the result of seepage from the paint layer or a reaction caused by adverse environmental conditions.

- Nature of 1926 glue – As discussed in Item 3.3.3.10 of this report, three samples of the glue were analysed by Kakoulli using FTIR and have been confirmed as proteinaceous glue[140]. It is recommended that more thorough research should be carried out into the nature of this glue in the next Phase of work[141]. At the team Meeting No 9 on the 7th December 1999 a suggestion was made that the Metropolitan Police Forensic Laboratory should be approached to carry out this analysis. If variations in performance of different types of "animal" glue are discovered in the future, at least those caring for this ceiling will know what they are dealing with.

- Nature of any applied surface coatings - Further research will be required to establish whether or not a surface coating was applied to this black paint. NB Shellac was present on one sample taken from a grey chevron board in 1997. Could this have been unintentionally applied when coating the adjacent black or is the shellac seepage of a timber treatment applied to the upper side? The paint on some obviously 1830s softwood boards has a characteristic milky or silvery surface sheen (see **Plate 395, 420**). Analysis indicates this is a thin pale coating as yet unidentified.

- Nature of Chemical stains – Particularly the lighter brown material has staining such as depicted in **Plate 471**. Also the material responsible for the light brown drips frequently found on the edge of ceiling boards or around holes and splits in the boards (see **Plate 474**). A sample of this material was analysed in Phase 2. Results were inconclusive beyond indicating the substance is organic.

11.3 Structure

- Dovetail joints – As discussed in Item 3.3.3.2, it is recommended that the roof timbers above the dovetail joints cut into the side of joists are inspected in the next Phase to see if they have evidence of timbers fixed to them.. If there is nothing, it would seem that these dovetails are evidence of pre-1830s repair. If this is the case,

[139] Kakoulli 1999: Sample 10
[140] Kakoulli 1999:
[141] Discuss with Project Team

thought should be given to analysing the nail found in one of the dovetails to see if this provides any clue as to its date[142].

- Hanging Bolts – As discussed in Item 3.3.3.7, in Phase 2 some hanging bolts were seen to have foundry marks on the shanks of the bolts and the washers. These should be recorded in Phase 3. Also, in Phase 3 any depressions in areas of boards which appear to have been deformed by overtightening the hanging bolts and all loose bolts should be recorded.

- Hessian and Glue - As discussed in Items 3.3.3.10 and 4.5, further investigation of the glue and hessian matrix is required. Specifically tests for glue melt and penetration and board gradient temperature. Also, further investigation of hessian patches and strips of canvas over the 1926 hessian layer is required[143].

- Death Watch Beetle in Original Boards – As discussed in Item 5.1.4.1, In view of the general preference by DWB to emerge through unpainted surfaces rather than through painted surfaces, many of which contained lead it would be interesting to plot the exit holes through the raised areas compared with the abraded areas. If there is a provable reduction in holes in the former, this might indicate differences in composition of paint used on different areas.

- Surface Degradation - As discussed in Item 5.1.7, the shallow relief found on the surface of many of the original boards remains an enigma. Brian Ridout was asked to comment, but this is a phenomenon he had never come across before, nor could he find any other reference in his library. He speculates that the cause may be some sort of soft rot or differential collapse of the wood cells, or chemical deterioration from the old coke stoves. In order to pursue this research, Ridout would need samples of the timber. It is recommended that this research is carried out, not the least because another example of the phenomenon has been found in St. Albans Cathedral Choir ceiling[144].

11.4 Documentary Research

- Further Documentary Research - As stated in Items 3.3.3.8 and 3.3.5.11, it is recommended that some effort is made to find out more documentary information on this phase of work either through Ansted who made the survey drawings, or Ruddles the builders, or Samuel Ware who made the drawing dated ca 1805. In addition, every source should be scoured to unearth any further documentary evidence of how the 1924/6 work was carried out[145].

[142] Ask Brian Gilmour to test nail.
[143] Discuss with Project Team
[144] Discuss with Project Team
[145] Discuss with Project Team

PART 12: THE NAVE CEILING: MAINTENANCE PROGRAMME

12.1 MONITORING AND MAINTENANCE

12.1.1 Environmental Monitoring

We shall collaborate with Tobit Curteis to ensure that the ongoing programme of environmental monitoring continues throughout the Phase 3 works. We shall ask to be informed of any conclusions drawn from preliminary analysis of data collected over the past year and would wish to participate in any discussions regarding the effect of environmental conditions on the Ceiling.

In his preliminary report[146] Curteis raises a number of queries that should be addressed by the members of the Project Team during the next phase of works. As these queries relate to investigations and measures fundamental to the long term care and stability of the Ceiling they are reproduced below:

- *Is there significant dimensional response in individual boards resulting from environmental fluctuations which. for some reason, is not presenting in the form of deterioration to the paint layer ?*
- *Is there dimensional response which is cumulative over large areas of the roof, causing significant movement or distortion within large areas of the structure. Could this lead to serious deterioration in the future ?*
- *Should we be measuring the levels of movement on either a small or large scale (i.e. for a small group of boards or for an entire bay), in order to be able to quantify it ?*
- *Should we consider introducing active controls on the environmental conditions within the body of the cathedral (heating management, water trays, control on ventilation) ?*
- *Should we consider controlling the roof space environment (covering windows, controlling ventilation, increasing insulation levels) ?*
- *What is the long term prognosis for the hessian backing, given the conditions we have recorded ? How much structural support does it give? Is it likely to deteriorate to the level where it will need to be replaced and if so, when ?*
- *While the author can comment on the impact of the environmental conditions on the polychrome surface of the ceiling, the dimensional response of large and complex wooden structures such as this, is entirely outside the author's field of experience. Given that the potential consequences are extremely serious if a problem does exist, do we have the relevant expertise within the project team to address this. If not, should we consult an expert in the dimensional response of historic panel paintings, with regard to the movement on a small scale and/ or a civil engineer, regarding possible large scale movements ?*

[146] *Peterborough Cathedral: Environmental Monitoring of the Nave Ceiling – March 1998-January 2000 (Preliminary Report)*. Tobit Curteis Associates.

12.1.2 Schedule of Inspection and Maintenance

- The Ceiling structure, upper side – It is recommended that the whole of the upper flat section of the ceiling is cleaned with a vacuum as part of the final Phase of work. Thereafter it must be agreed whether light covers are made for the ceiling which would substantially reduce the dust falling on the ceiling and create some sort of environmental buffer both as regards temperature and humidity. Or whether the ceiling is to be left open, in which case it will probably need vacuuming every 5 years.

  All the telltales inserted in the first two phases will be inspected during Phase 3, and it is suggested that all telltales are inspected as part of the final Phase of work. Thereafter, they should be inspected every 5 years. Any movement found should be reported to the Cathedral Architect.

- The Ceiling structure, lower side and the painted decoration - The phased programme of works to the Nave Ceiling is planned for completion in 2002. For the duration of the phased programme we propose an annual inspection of the previously treated Bays to be carried out by the Perry Lithgow Partnership and Hugh Harrison. The inspection should be from the clerestory, (north and south sides) using binoculars as well as existing photographic documentation for reference. A brief inspection report to be compiled and appended to the condition and treatment report for the current phase of work. In 2003 we propose that the entire Ceiling be inspected from a mechanical hoist. By then 5 years will have elapsed since Phase 1 (1998). A close inspection of the surface at that time should provide useful information on the stability of the structure and paint as well as the effectiveness of treatment measures, albeit over a relatively short term. In addition, there will be an opportunity to assess the rate of dust accumulation under present conditions in the building. These factors will determine a schedule for inspection and maintenance thereafter.

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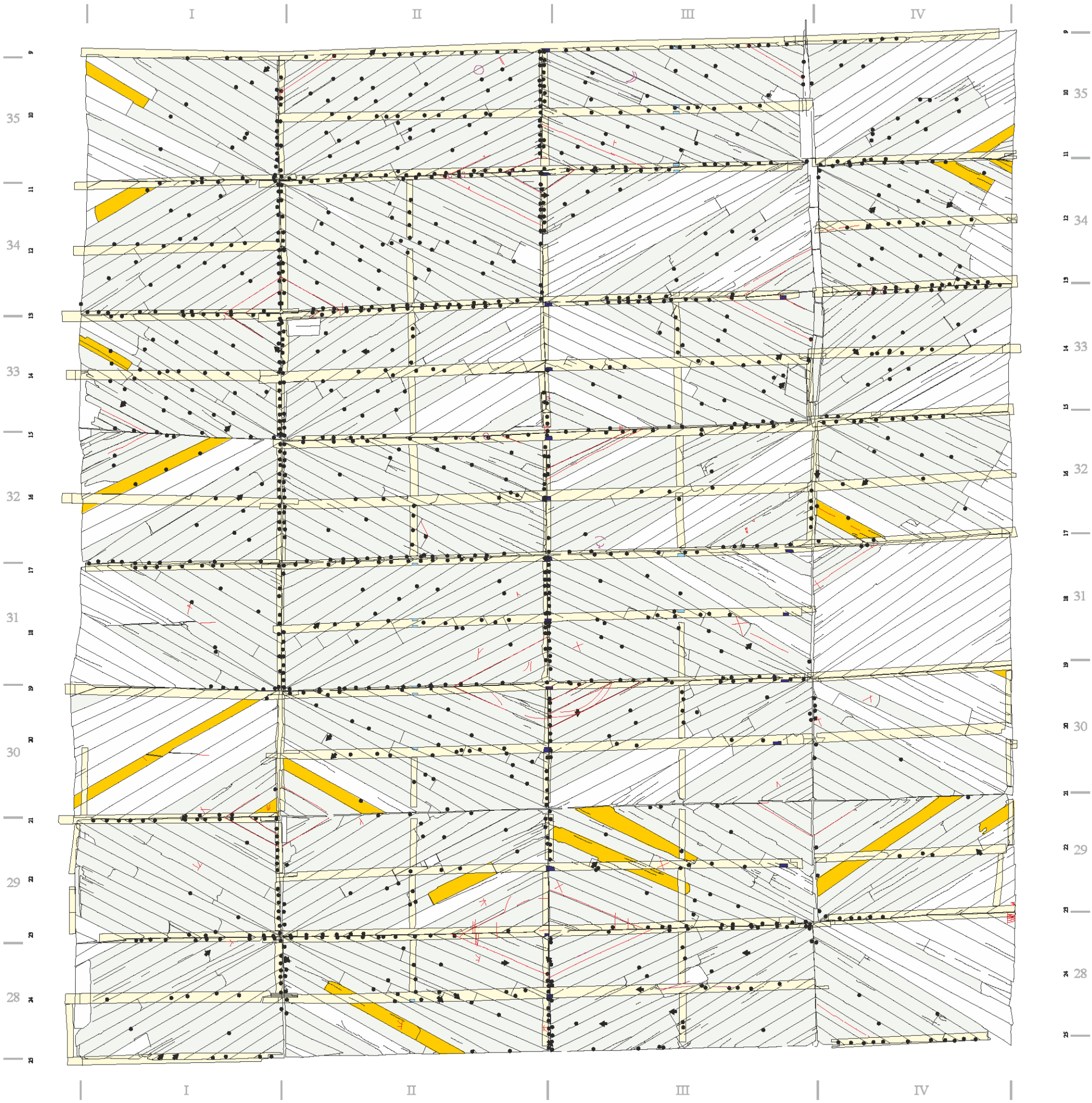
PART 14: CONDITION AND TREATMENT GRAPHIC RECORD

The following **Graphics 1 - 12** constitute detailed condition and treatment records of the painted decoration and the Ceiling structure upper and lower sides.

EAST



WEST

NOTES

The major change to the structure in Phase 2 is the addition of noggins from Joist 9 between the centre noggin and those at the scissor joints. Note should also be taken of how few nails fix boards to these intermediate noggins, more probably existed at one time as can be seen from the nail holes shown on **Graphics 6A/B**. Note also the carpenter's marks, some of which seem to be for locating adjoining boards, and some, the painted design. Hessian was not removed above every noggin, so the categorisation of noggins as original or from a later intervention is not always precise.

KEY

- Original nail heads
- Protruding original nail heads
- Dovetail joints
- Birdsbeak joints
- Original joists
- Original noggins
- Original ceiling boards
- Oak replaced ceiling boards
- Original alignment grooves
- Original incision lines
- Edges of all ceiling boards

GRAPHIC NO: 1

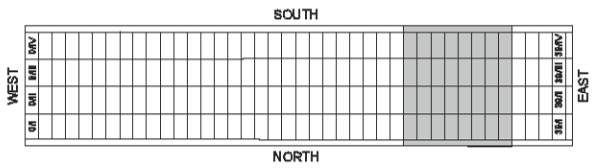
N

CEILING STRUCTURE

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels



TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE TECHNICAL SURVEY

DESCRIPTION Surviving Original Ceiling Elements

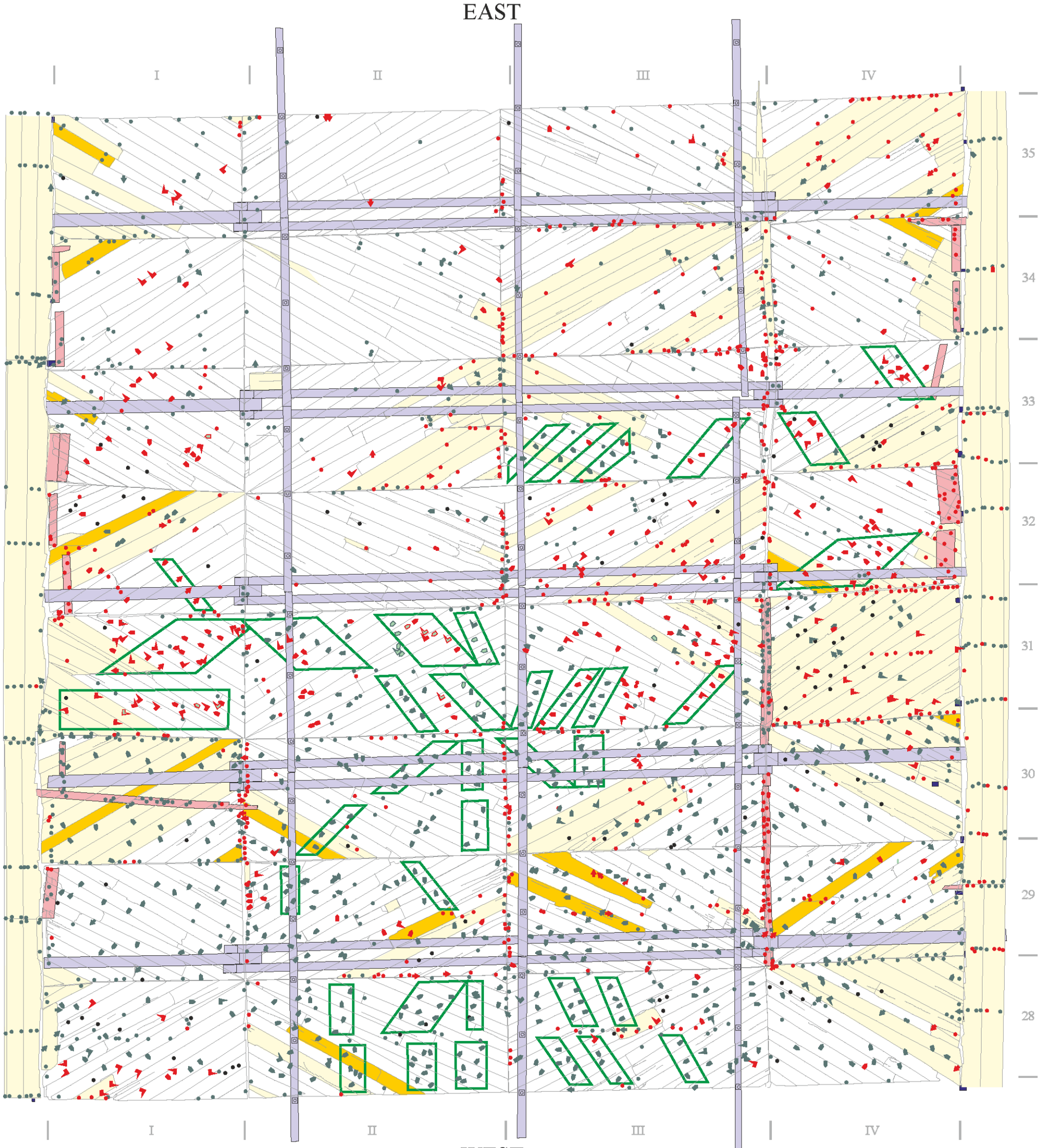
Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

The Perry Lithgow Partnership
1 Langston Lane, Station Rd, Kingham,
Oxon OX7 6UW Tel. 01608 658067

EAST

I II III IV

35 34 33 32 31 30 29 28



I II III IV

WEST

NOTES

So far it has been impossible to apportion repairs to either the 1740s or 1830s restorations, so all the work attributed to both campaigns is shown on this Graphic. It is known that many repairs of this period were stripped out in the 1926 restoration (of which it is conjectured that many of the nails driven from above are evidence), so this Graphic should not be taken as a full picture of all work from this period. It is interesting to note the single replaced joist in *Panel 30 I,* the patches at the foot of the sloping panels, the reused original oak ceiling boards as well as the replaced noggins at the south scissor joint. The 1830s roof is shown from which the ceiling is now suspended by hanging bolts.

KEY

- Trusses
- Binder with ceiling bolts
- Collars
- 1830s reinforcements
- Oak replaced ceiling boards
- Softwood replacement boards
- Added sq. nail heads
- Added sq. nail ends
- Added flat nail heads
- Added flat nail ends
- Nail holes (ex nail ends)
- Edges of all ceiling boards
- Vertical post
- Position of conjectural patches
- Investigated nail ends

GRAPHIC NO: 2

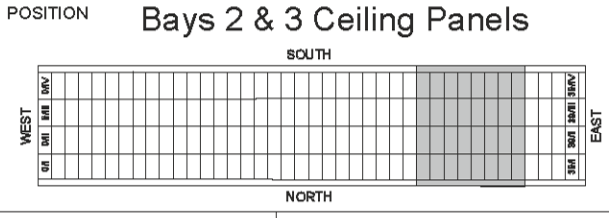
N

CEILING STRUCTURE

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels



TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE TECHNICAL SURVEY

DESCRIPTION Extent of Surviving C18/19th Eork

Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

The Perry Lithgow Partnership
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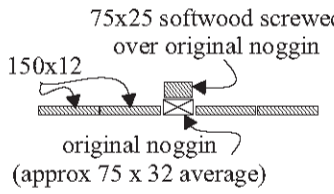
I II III IV

EAST

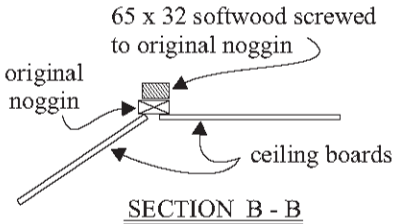
WEST

I II III IV

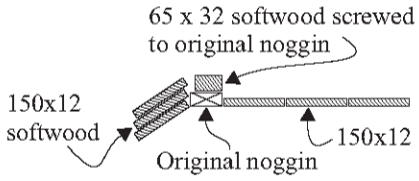
NOTES The 1926 restoration is characterised by the complete new system for supporting the ceiling using softwood noggins, patches, a number of laminated joists (all items mostly fixed with screws) and a complete layer of hessian. The work caused considerable damage to the face of the painted boards arose because there was no access below the ceiling to see what was happening. In addition, binders were installed to carry the sloping ceiling panels.



SECTION A - A



SECTION B - B



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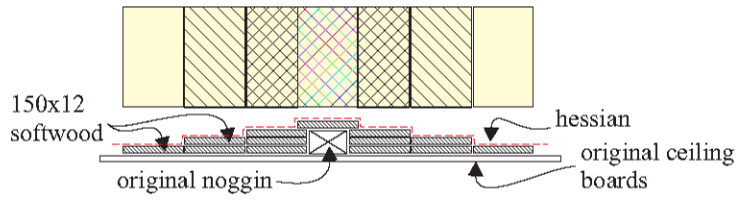


Diagrammatic plan and section to show maximum of 4 levels of strengthening to original noggins. The method is reduced according to individual circumstances, each of the levels built up by the use of individual 150 x 12 mm impregnated softwood boards. The same method applies at interface of sloping and horizontal boards.

KEY

- Binder with coach screw
- Original joist
- Original noggin
- 1830s reinforcements
- 1926 composite joist
- 1926 softwood patch
- Canvas strip
- Hessian patch
- Hessian patch over timber structure
- Hessian patch continuing under timber
- Iron screws
- Galvanised screws
- Edges of ceiling boards
- 1926 noggins & additions
- Vertical post
- Pinholes

GRAPHIC NO: 3

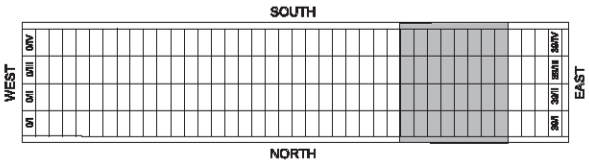
N

CEILING STRUCTURE

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels



TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Extent of 1926 Restoration

Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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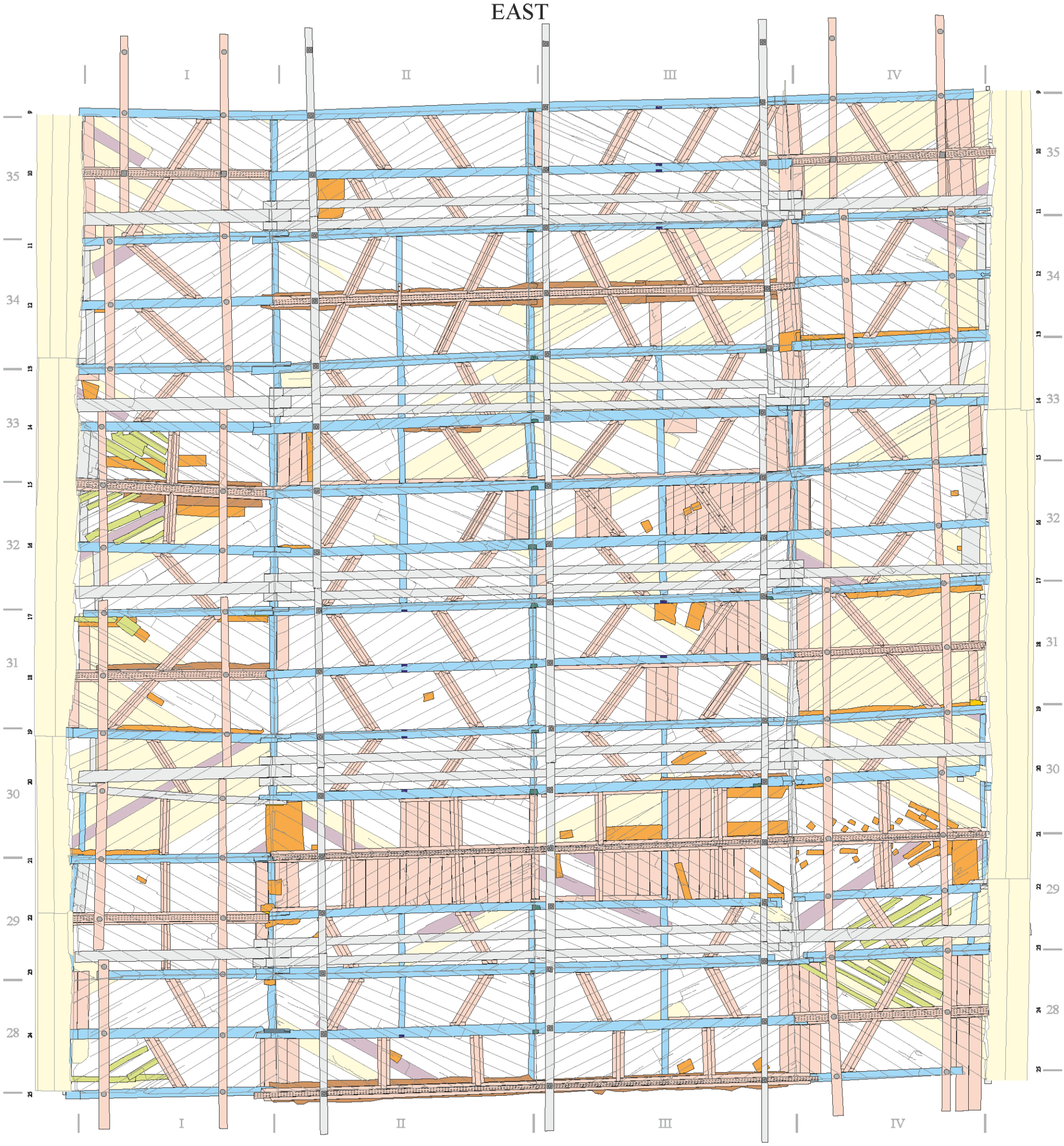


WEST

KEY

- Dovetail joints
- Empty joints
- Softwood Replacement boards
- Oak replaced ceiling boards
- Edges of all ceiling boards
- Original joists
- Original noggins
- 1830 truss
- 1830 collar
- Vertical post
- 1830 binder with ceiling bolt
- 1830s reinforcements
- 1926 binder with coach screw
- 1926 composite joist
- 1926 softwood patch
- 1926 added noggins
- Canvas strip
- Hessian patch
- Hessian patch continuing under timber

NOTES

This Graphic shows the total extent of current structure with all the original material coloured blue, all the 1740s/1830s in grey and the 1926 restoration in pink. The hessian covering is not shown, although the additional hessian patches and canvas strips are shown.

GRAPHIC NO: 4

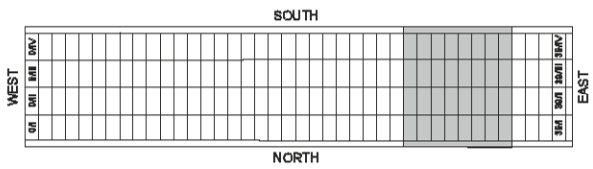
N

UPPER SIDE OF CEILING STRUCTURE

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels



TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE TECHNICAL SURVEY

DESCRIPTION Current Extent of Ceiling Structure

Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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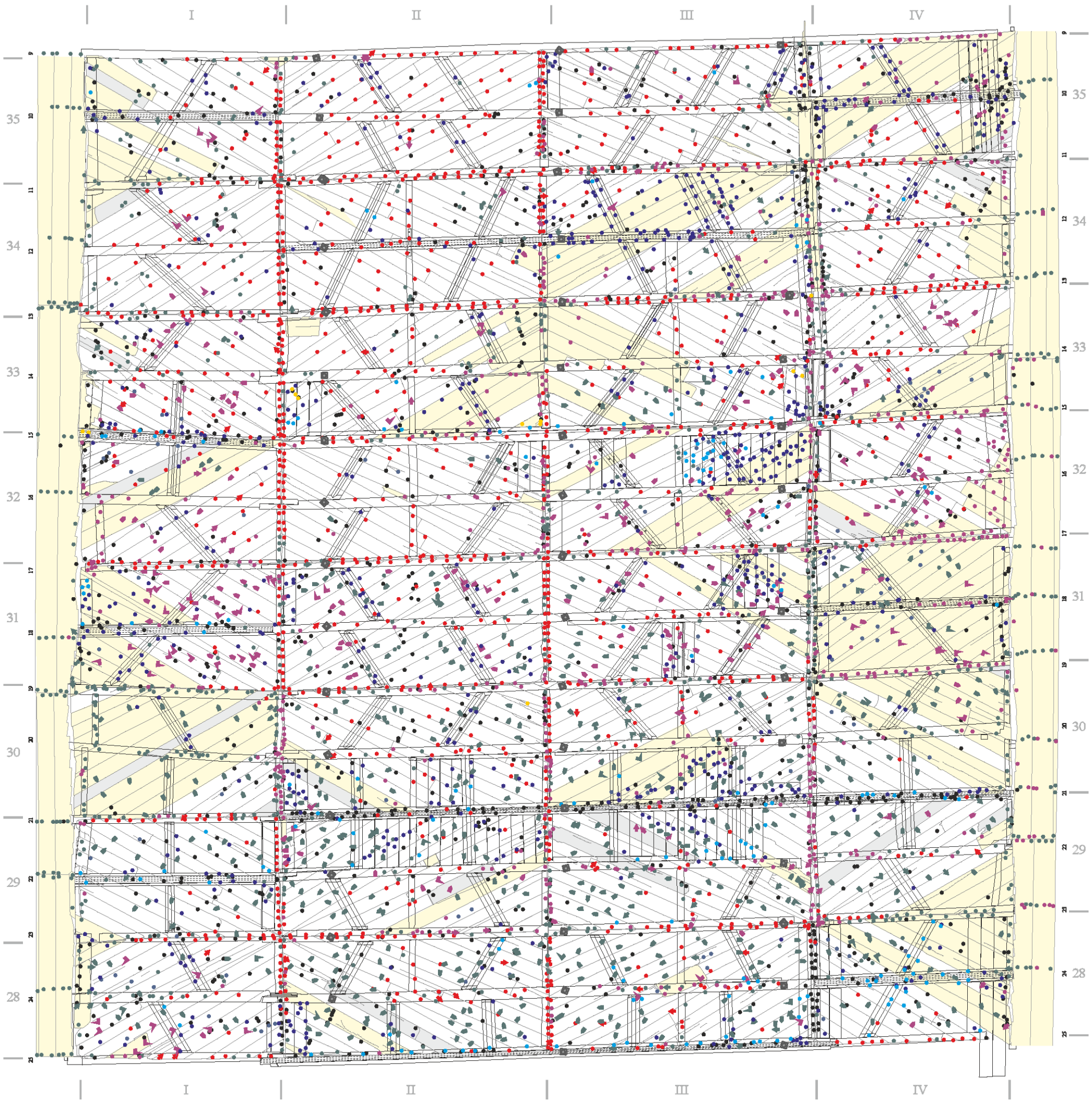
EAST



WEST

KEY

- Softwood Replacement boards
- Oak replaced ceiling boards
- Original joists
- Original noggins
- 1830s reinforcements
- 1926 composite joist
- 1926 softwood patch
- Vertical post
- Added sq. nail heads
- Added sq. nail ends
- Added flat nail heads
- Added flat nail ends
- Original nails
- Projecting nail heads
- Projecting nail ends
- Edges of all ceiling boards
- 1926 added noggins
- Ceiling bolts
- Galvanised screws
- Iron screws
- Screw heads

NOTES This Graphic shows the extent of fixings that currently exist attaching the ceiling boards to the structure above. It should be remembered that this Graphic does not include nail holes, so that when these are added, the full extent of the damage to the painted boards can be appreciated through indiscriminate nailing. It is interesting to speculate whether the protruding screws from the 1926 restoration would have been accepted if there had been a scaffold beneath the ceiling so that the damage they were causing would have been immediately obvious.

GRAPHIC NO: 5

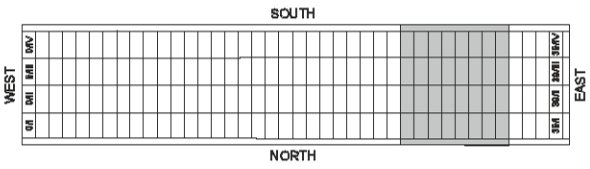
N

LOWER SIDE OF CEILING

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels



TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE TECHNICAL SURVEY

DESCRIPTION Extent of Metal Fixings

Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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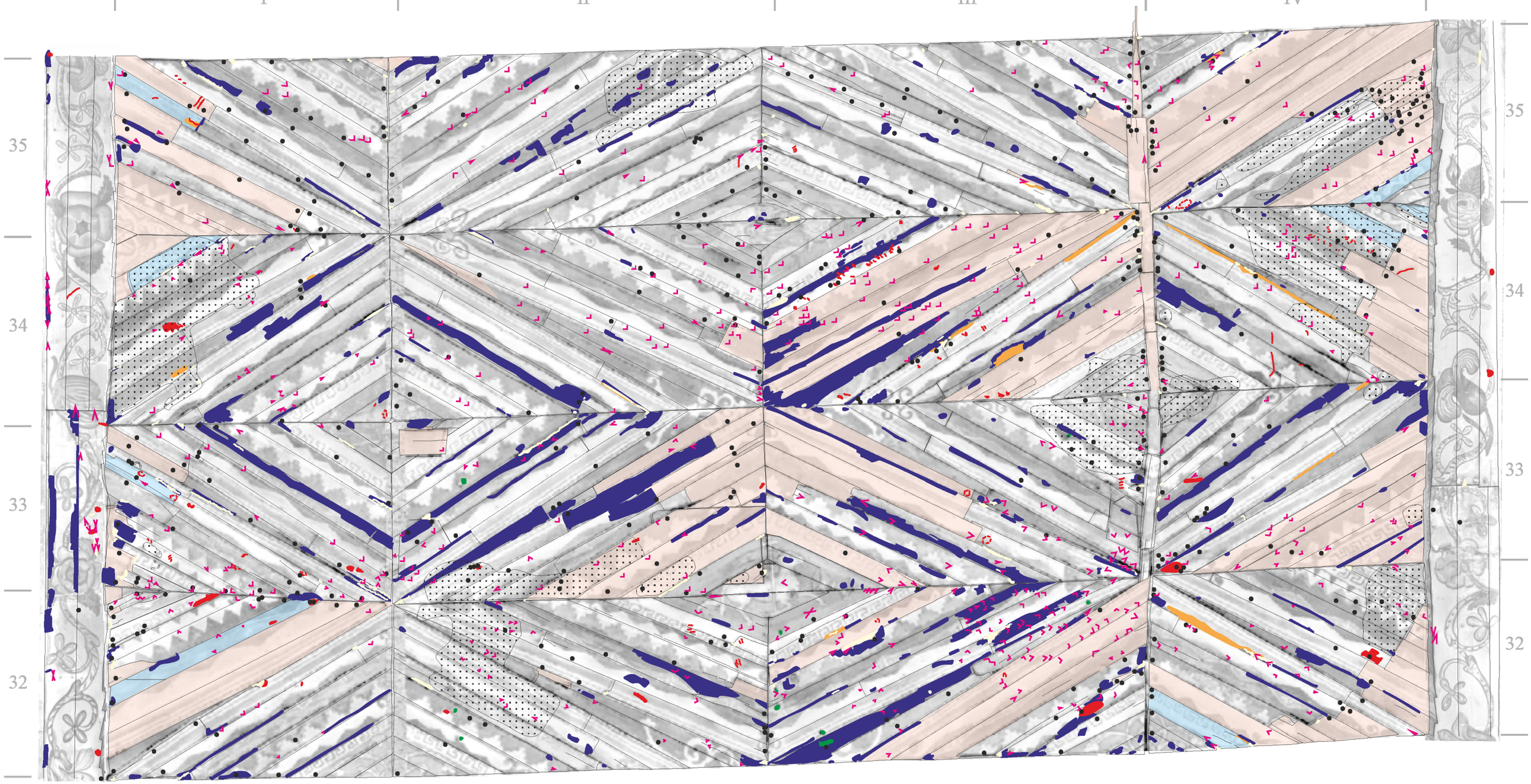


KEY FOR DAMAGE TO CEILING BOARDS

- Wood loss
- Nail holes (ex nail heads)
- Intended wood loss
- Shot damage
- Insect damage
- Wet rot & insect damage
- Impact damage
- Replaced boards
- Repositioned oak boards
- Surface splintering

GRAPHIC NO: 6A

SCALE 1:35

0 1m 2m 3m

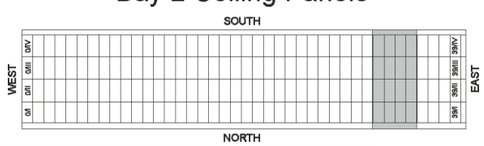
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Damage to Ceiling Boards

POSITION Bay 2 Ceiling Panels



Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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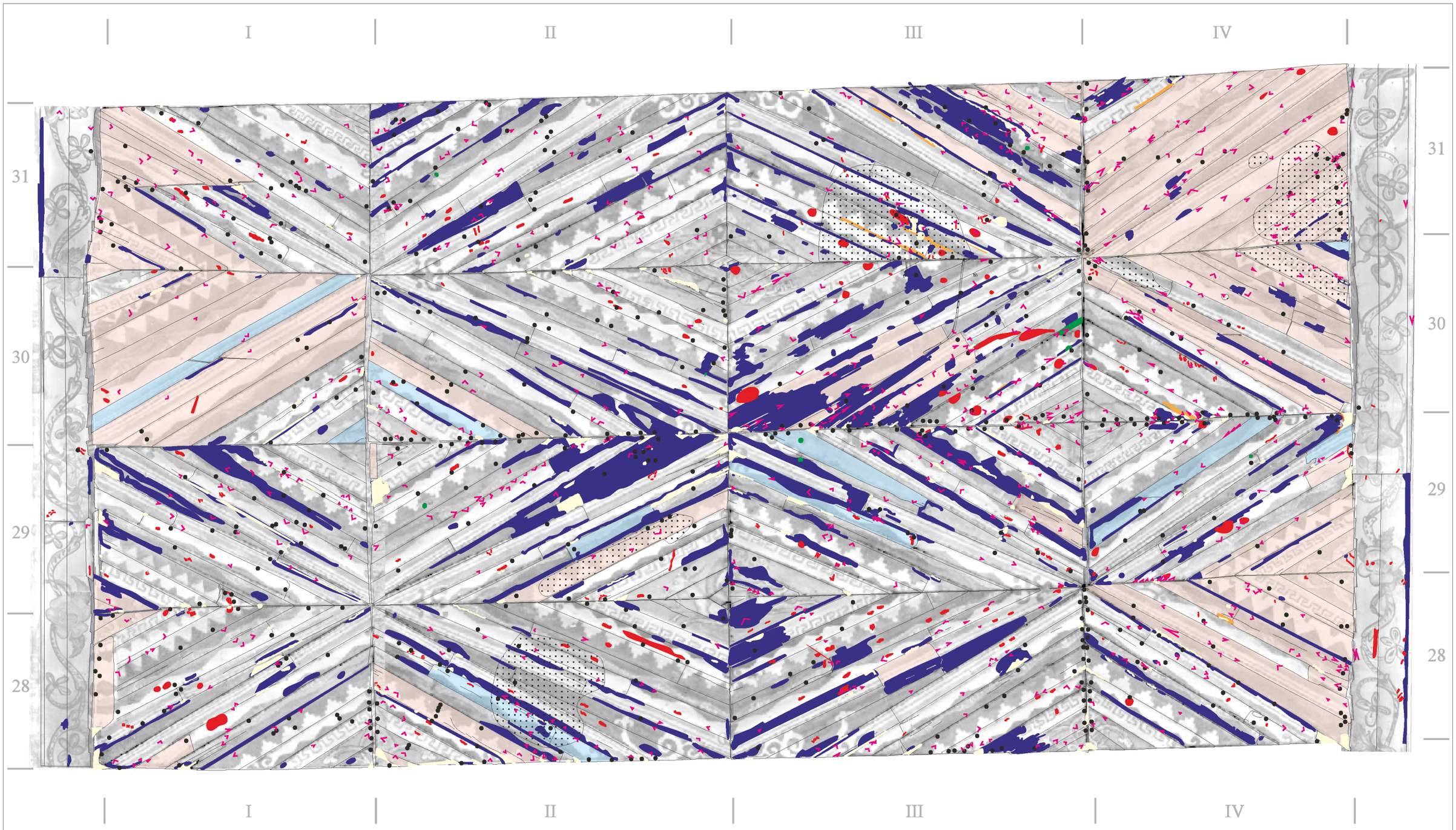
NOTES

Decay - The pattern of decay remains similar to that found in Phase 1, with a greater retention of original boards in the flat section of ceiling, and with a corresponding increase in insect damage. It should be noted how few original boards survive at the base of the sloping panels.

Shot - The shot damage has been assessed as pre- or post the 1830s restoration depending on whether there is paint in the shot holes. However it is noticeable that no shot exists on the ashlar boards, so if shooting did continue after 1830, it probably points to the shooting having been carried out from the floor of the Cathedral from where the ashlar boards are hardly visible.

Wood loss - Note the holes etc. cut in the ceiling boards marked as Intended wood losses.

Repositioned oak boards - Note the number of original boards that have been reused, marked in light blue as Repositioned oak boards.



KEY FOR DAMAGE TO CEILING BOARDS

- Wood loss
- Nail holes (ex nail heads)
- Intended wood loss
- Shot damage
- Insect damage
- Wet rot & insect damage
- Impact damage
- Replaced boards
- Repositioned oak boards
- Surface splintering

GRAPHIC NO: 6B

N

SCALE 1:35

0 1m 2m 3m

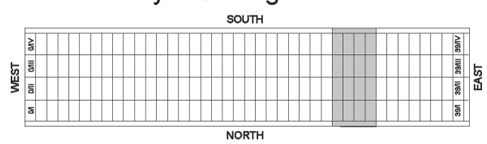
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Damage to Ceiling Boards

POSITION Bay 3 Ceiling Panels



Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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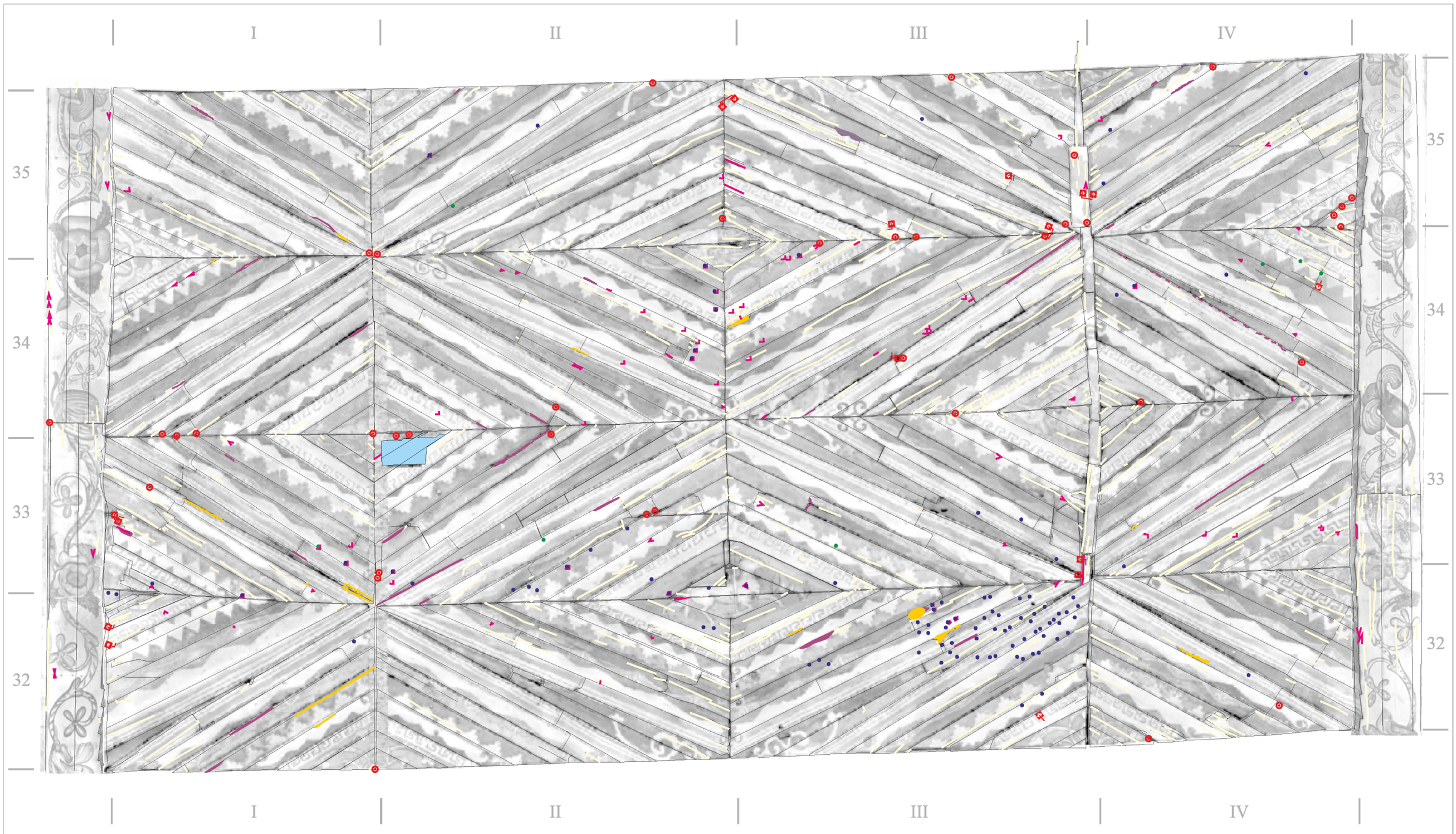


KEY FOR REPAIRS TO CEILING BOARDS

Timber inserts — Splits in boards

Consolidation:

B72 — Bencon 19

Fills — B500 Adhesive

Stainless steel fixings:

Screw & Washer — Angled Rod

Threaded Rod — Bolt

Screws Removed — Screws Replaced

GRAPHIC NO: 7A

SCALE 1:35

0 1m 2m 3m

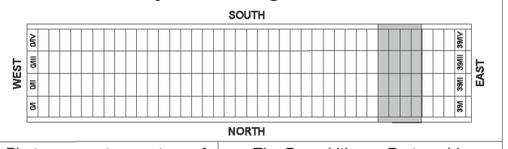
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Repairs to Ceiling Boards

POSITION Bay 2 Ceiling Panels



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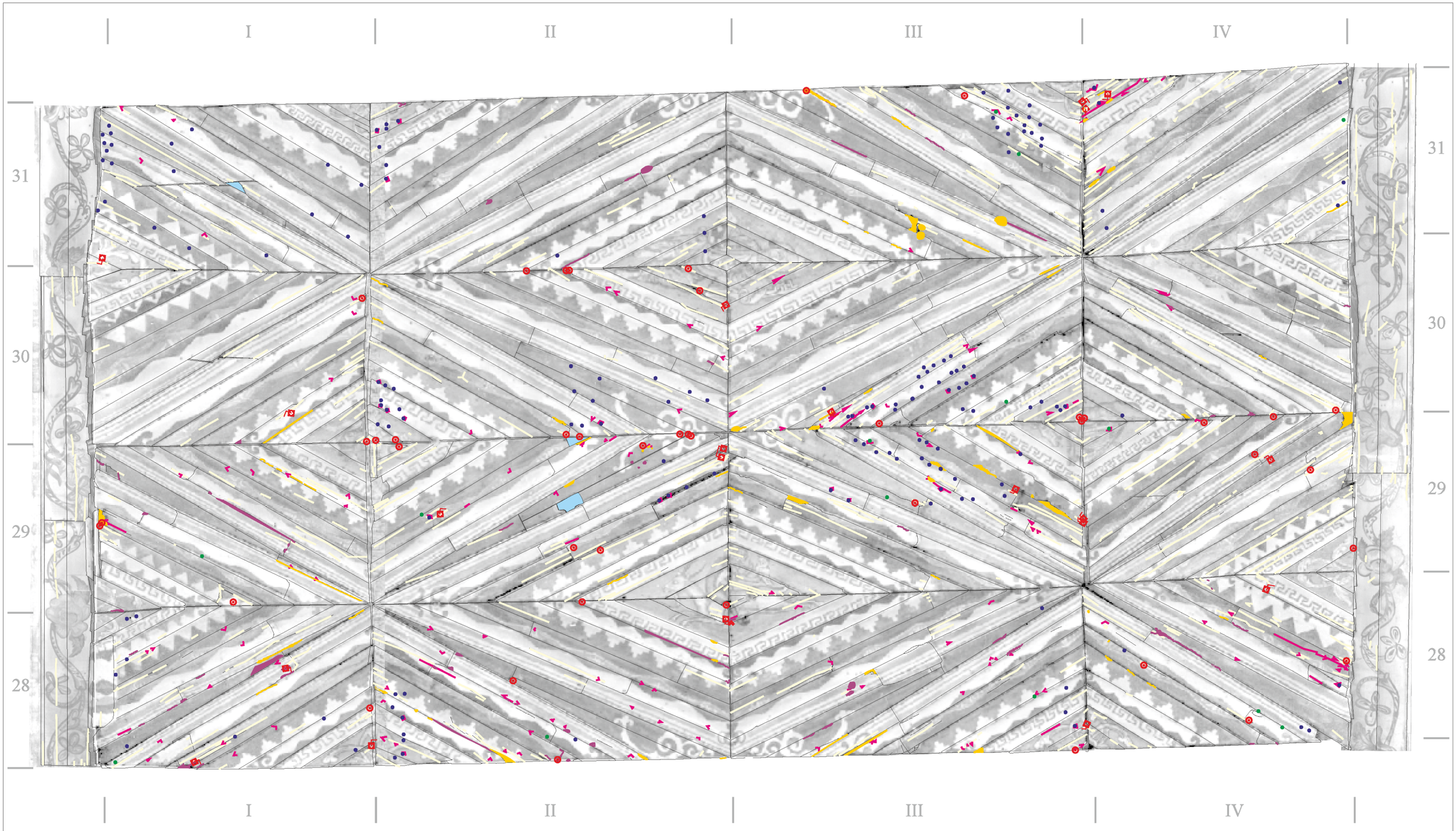
NOTES

Consolidation - It is noticeable that consolidation by Paraloid B72 with associated fillings has been used in areas of insect damage and fungal decay. Only one board required consolidation with Bencon 19 in this phase of work.

Stainless steel fixings and screws - As for Phase 1 these were used to secure loose fragments of the ceiling boards.

Timber inserts - The location of the new oak inserts is shown here in blue.

Replaced screws - Where protruding 1926 screws can be accessed from above simply by peeling away the hessian above the screw head, these were removed and replaced with shorter stainless steel screws.



KEY FOR REPAIRS TO CEILING BOARDS

Timber inserts — Splits in boards

Consolidation:

B72 — Bencon 19

Fills — B500 Adhesive

Stainless steel fixings:

Screw & Washer — Angled Rod

Threaded Rod — Bolt

Screws Removed — Screws Replaced

GRAPHIC NO: 7B

SCALE 1:35

0 1m 2m 3m

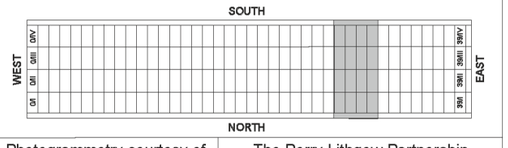
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Repairs to Ceiling Boards

POSITION Bay 3 Ceiling Panels



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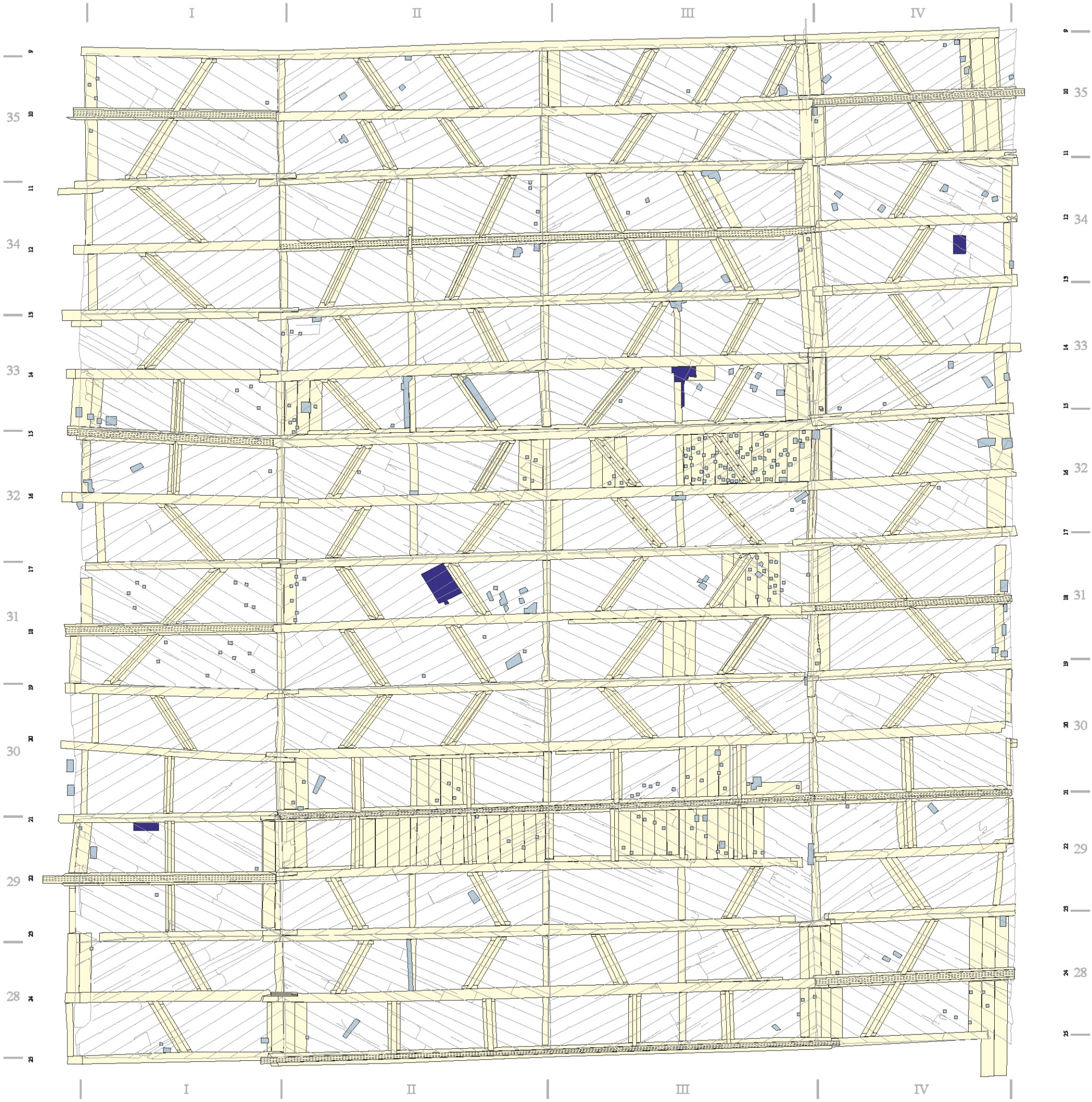
EAST



WEST

NOTES

All new sailcloth patches used in Phase 2 to repair the 1926 hessian layer are marked, also the positions of hessian sampleswhich were removed and sent to the Tate Gallery for testing.

KEY FOR NEW SAILCLOTH

- Original joists
- Original noggins
- 1830s reinforcements
- 1926 composite joist
- 1926 softwood patch
- Sailcloth
- Sailcloth over removed hessian samples

Edges of all ceiling boards

Added noggins

GRAPHIC NO: 8

SCALE 1:50

0 1m 2m 3m 4m

TITLE

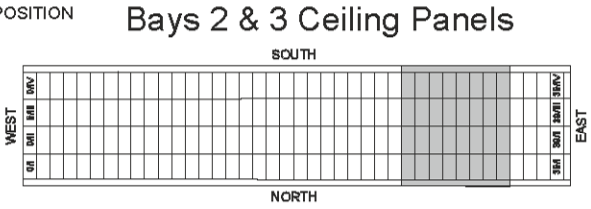
PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE: TREATMENT

DESCRIPTION: New Sailcloth Patches

UPPER SIDE OF CEILING STRUCTURE

POSITION: Bays 2 & 3 Ceiling Panels



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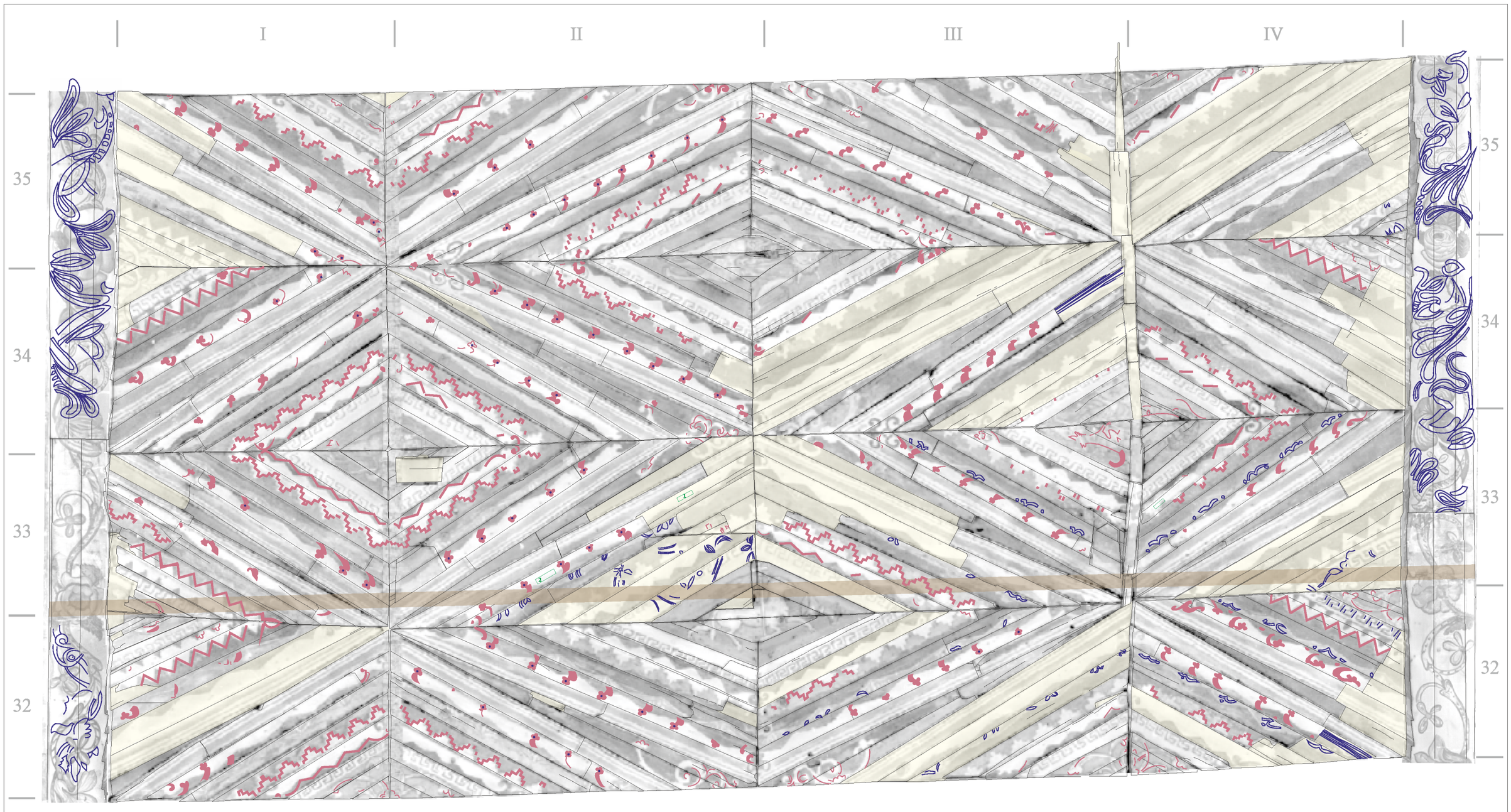


KEY FOR VISIBLE UNDERPAINT

- Edges of ceiling boards
- # Graffiti
- Original designs
- 1740s and 1830s designs
- Position of 1880s screening
- Softwood ceiling boards

GRAPHIC NO: 9A

SCALE 1:35

0 1m 2m 3m

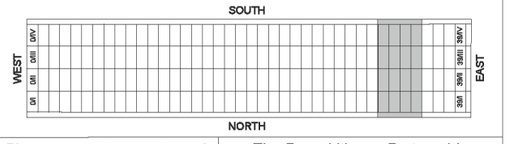
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Visible Underpaint & Graffiti

POSITION Bay 2 Ceiling Panels



Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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NOTES

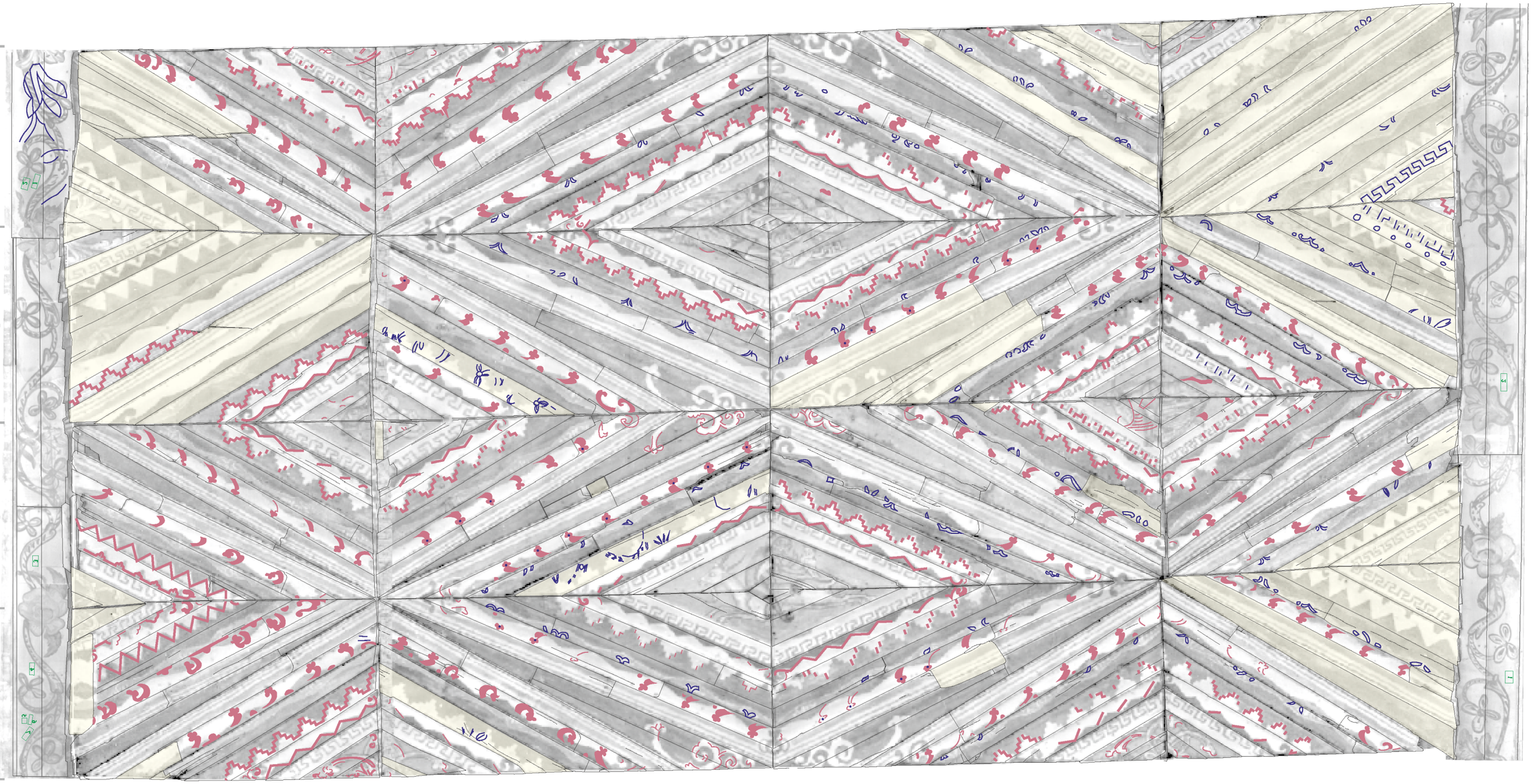
1880s screen - Findings during this phase suggest that the nave was screened off during the rebuilding of the tower in the 1880s . A band of thick dirt across the ceiling boards in Bay 2, Row 32 coincides with vertical strips of masking tape adhered to the north and south Ashlar boards.

Graffiti - Some 1880s pencilled graffiti exists on the ceiling boards to the west of the 1880s screening. On the Ashlar boards in Bays 1, 2 and 3 there are a number of examples recording that limewash was scraped from the nave walls during 1890.

Visible Underpaint - All evidence of the original and 1740s painted scheme visible in raking light beneath the 1830s repaint is plotted on this graphic, including 1830s underpaint on the Ashlar boards west of *Row 33* and the frieze scheme visible as underpainting on a number of softwood replacement ceiling boards .

I II III IV

31 30 29 28



KEY FOR VISIBLE UNDERPAINT

- # Graffiti
- Original designs
- 1740s and 1830s designs
- Position of 1880s screening
- Softwood ceiling boards
- Edges of ceiling boards

GRAPHIC NO: 9B

N

SCALE 1:35

0 1m 2m 3m

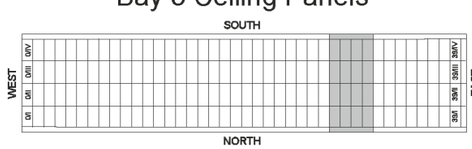
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Visible Underpaint & Graffiti

POSITION Bay 3 Ceiling Panels



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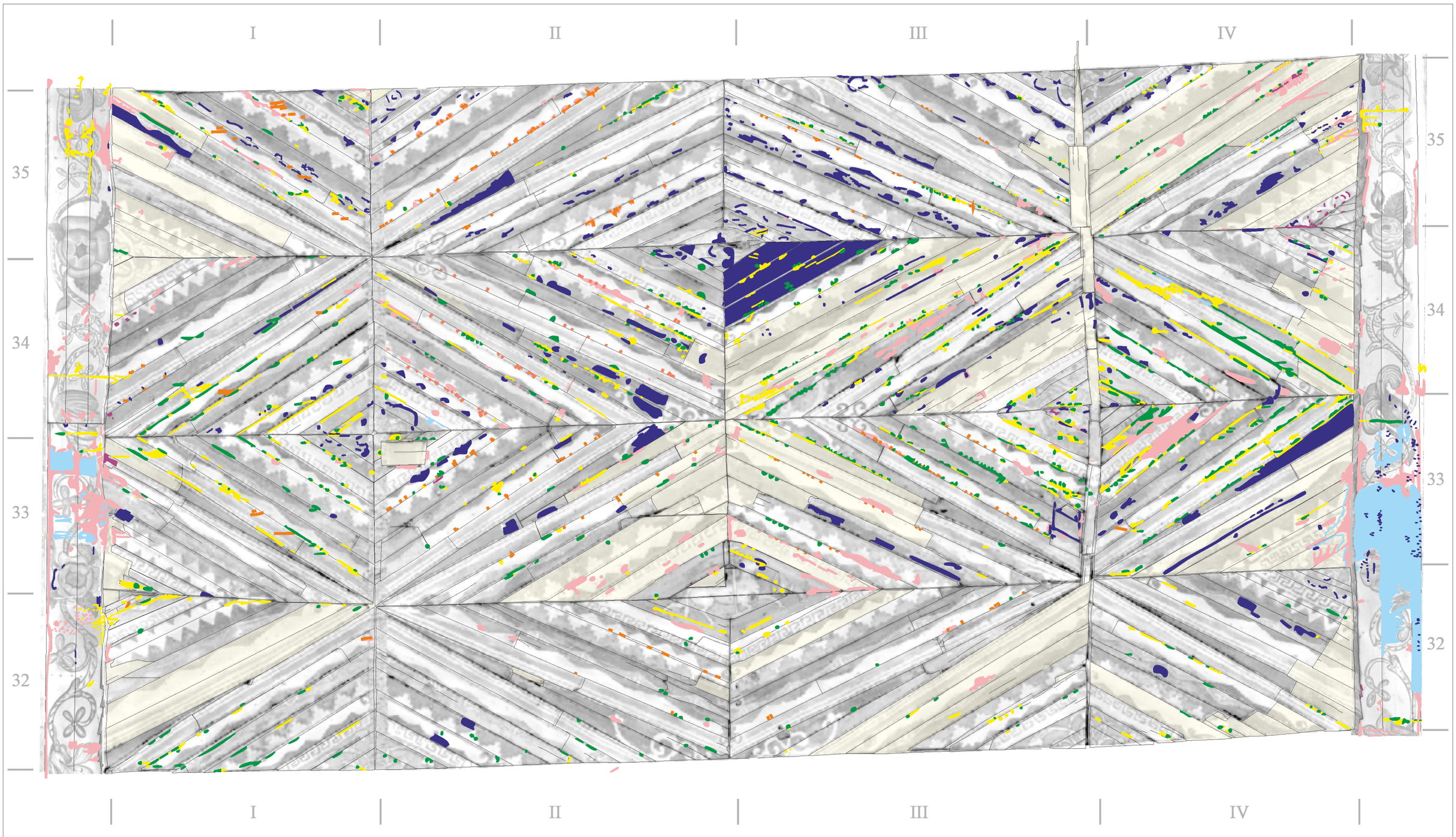


KEY FOR PAINT & SURFACE ACCRETIONS

- Flaking Paint and Glue
- Surface Glue
- Flaking Paint
- Brown Drips
- Water Damage
- Chemical Stains
- Efflorescence
- Softwood ceiling boards

Edges of ceiling boards

GRAPHIC NO: 10A

N

SCALE 1:35

0 1m 2m 3m

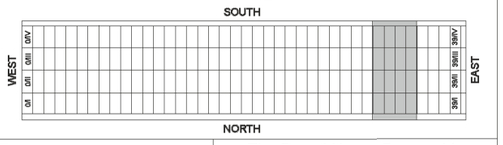
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Paint & Surface Accretions

POSITION Bay 2 Ceiling Panels



Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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NOTES

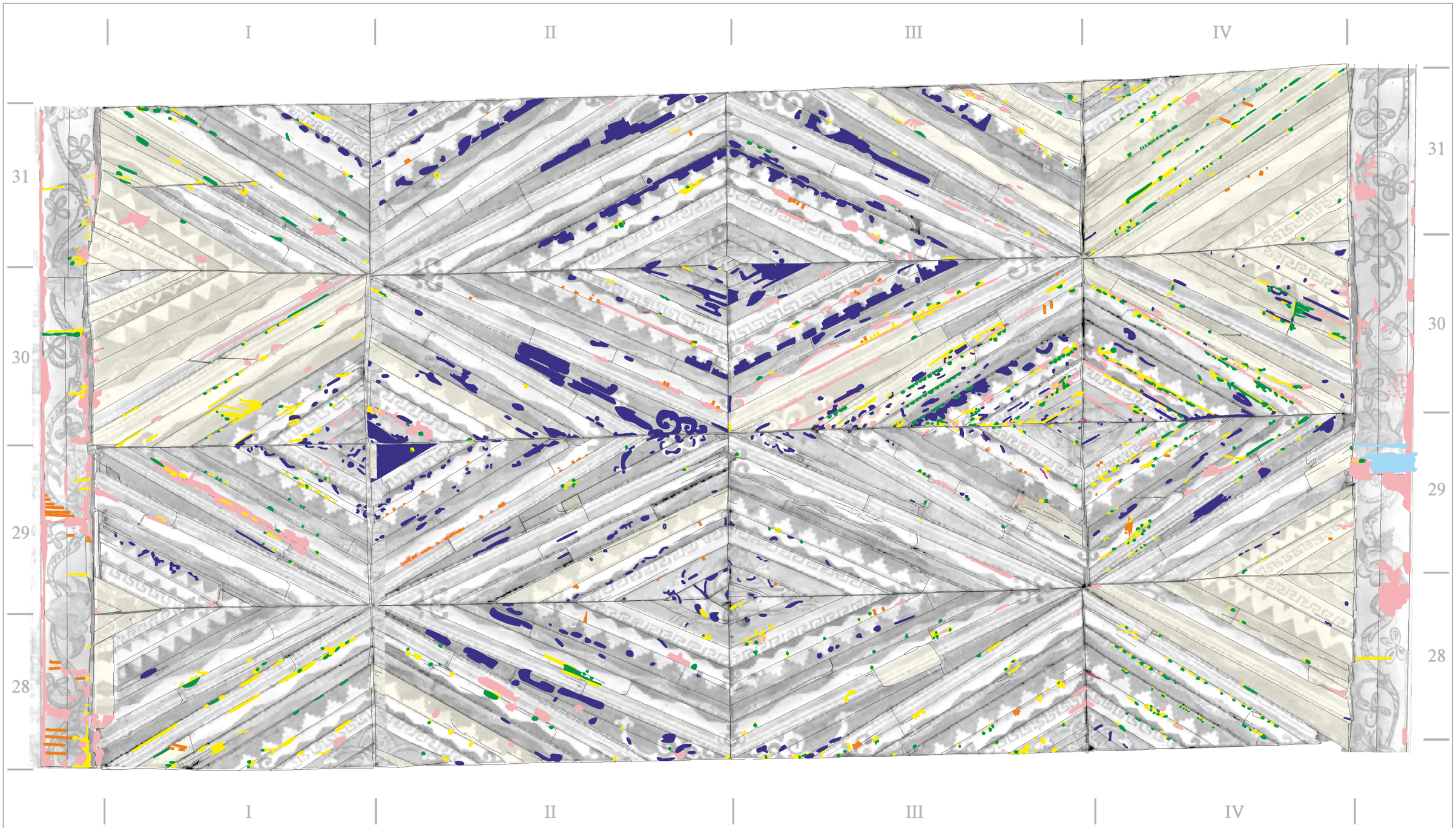
Flaking Paint - The primary cause of flaking paint on the Nave Ceiling is long term water infiltration leading to deterioration of the wood support and subsequent loss of adhesion. All flaking paint was re-attached during treatment.

Glue - The extensive glue deposits on the edges of straight-edged boards cannot be shown here. As far as is possible all glue deposits on the surface were removed.

Flaking & Glue - In general, the glue caused paint flaking only where it had collected in thick droplets or runs. Glue deposits are less likely to cause flaking of the more robust white background paint.

Staining - All stains on the painted decoration result from liquid material penetrating down between the boards or through cracks in deteriorated boards.

Efflorescence - Most characteristic is the 'white chalk line' on a number of original, wave pattern boards with the mat, saturated, black paint: at least two different salts are present, chloride and sulphate. All efflorescence was removed.



KEY FOR PAINT & SURFACE ACCRETIONS

- Flaking Paint and Glue
- Surface Glue
- Flaking Paint
- Brown Drips
- Water Damage
- Chemical Stains
- Efflorescence
- Softwood ceiling boards

Edges of ceiling boards

GRAPHIC NO: 10B

N

SCALE 1:35

0 1m 2m 3m

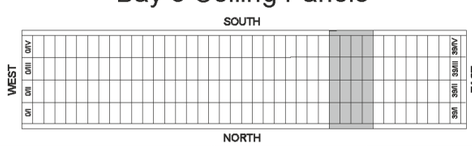
TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE CONDITION SURVEY AND TREATMENT

DESCRIPTION Paint & Surface Accretions

POSITION Bay 3 Ceiling Panels



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NOTES

Flaking Paint - The primary cause of flaking paint on the Nave Ceiling is long term water infiltration leading to deterioration of the wood support and subsequent loss of adhesion. All flaking paint was re-attached during treatment.

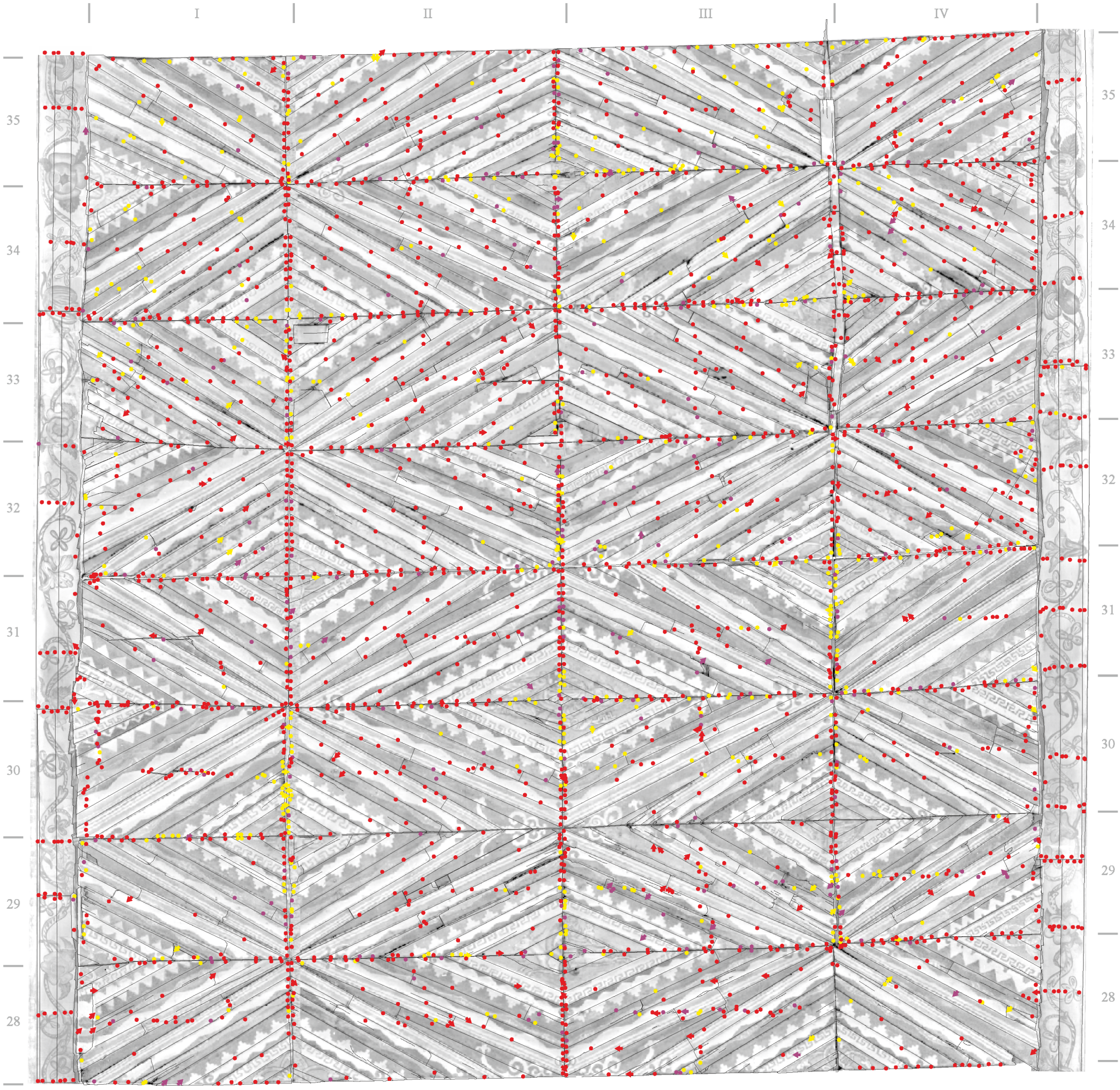
Glue - The extensive glue deposits on the edges of straight-edged boards cannot be shown here. As far as is possible all glue deposits on the surface were removed.

Flaking & Glue - In general, the glue caused paint flaking only where it had collected in thick droplets or runs. Glue deposits are less likely to cause flaking of the more robust white background paint.

Staining - All stains on the painted decoration result from liquid material penetrating down between the boards or through cracks in deteriorated boards.

Efflorescence - Most characteristic is the 'white chalk line' on a number of original, wave pattern boards with the mat, saturated, black paint: at least two different salts are present, chloride and sulphate. All efflorescence was removed.

EAST



WEST

NOTES

Paint Surviving on Nail Heads -The nail heads are shown here as oversized to aid visibility. The groupings signify the percentage of paint remaining on each nail but do not indicate whether the surviving paint was flaking. The same material in the same solution (Paraloid B72: 10% in acetone) was used both to re-attach flaking paint on nail heads and to coat exposed metal.

KEY FOR PAINT ON NAILS

Paint Surviving on Nail Heads:

- 70-100%
- 30-70%
- 0-30%

Edges of ceiling boards

GRAPHIC NO: 11

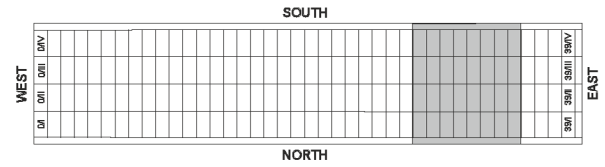
N

LOWER SIDE OF STRUCTURE

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels



TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE TECHNICAL SURVEY

DESCRIPTION Paint on Nail Heads

Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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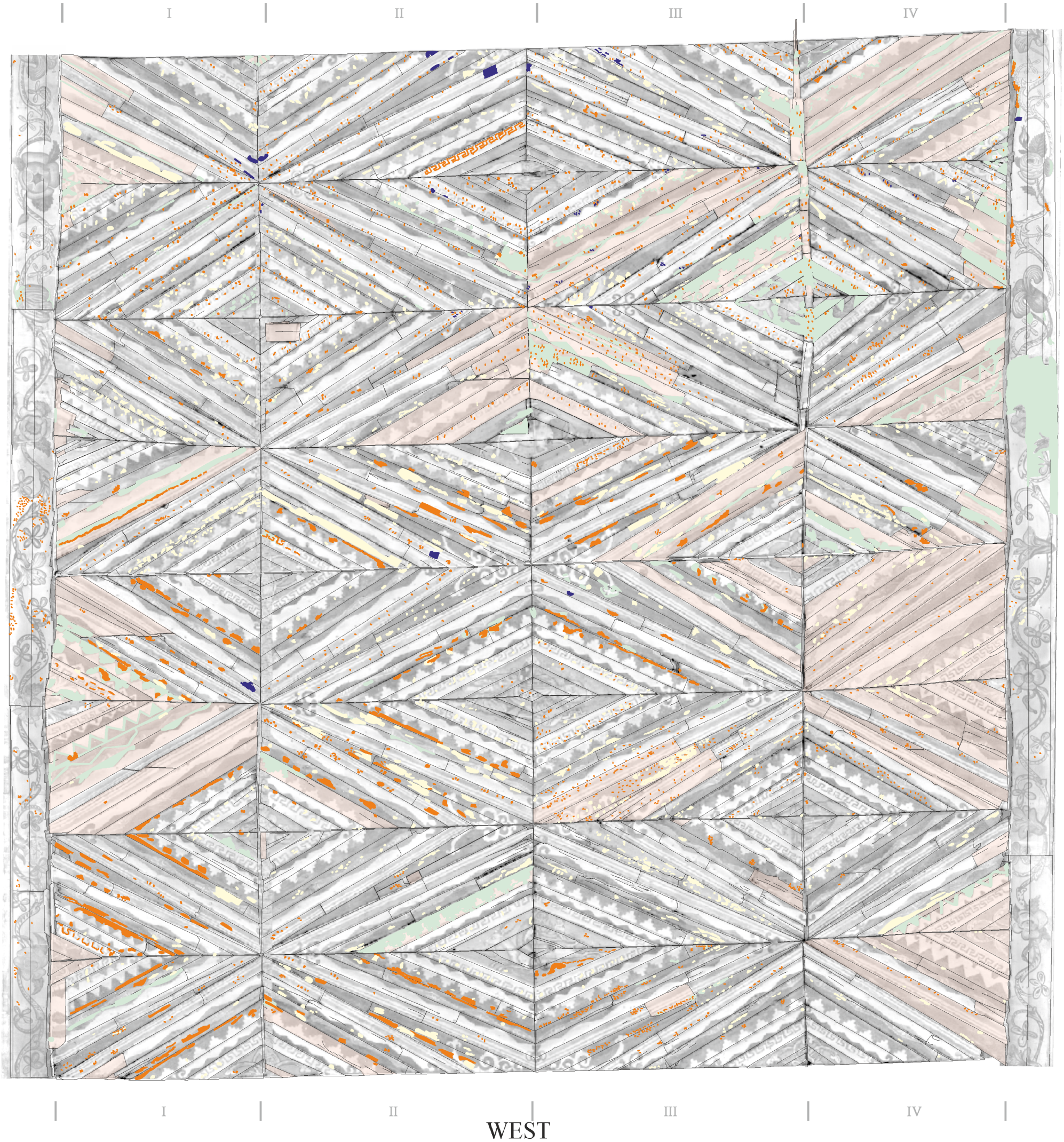
EAST

I II III IV

35 34 33 32 31 30 29 28



I II III IV

WEST

NOTES ***Patchy white deposits -*** Associated with the thick resinous 1830s black paint/coating remain unidentified. Analysis indicates they are accumulations of irregularly shaped, translucent, plate-like crystals. Further investigations are required to determine whether these crystalline deposits are the result of seepage from the paint layer or a reaction caused by adverse environmental conditions. ***Tendril deposits -*** These resemble miniature spider web, joining larger elements together. This type of deposit may have originated through microbiological action: analysis found some collapsed strand material. ***Brown/white blotches -*** Irregularly shaped, translucent granules. The spots are generally brown and at the centre there appears to be a dark brown particle, like a grain of sand, around it is a lighter brown or off-white halo with a fuzzy edge. ***Surface Bloom -*** Nearly all surface bloom recorded in Phase 2 occurs on 1830s softwood boards. The boards appear to have a coating of white dusty material.

KEY FOR SURFACE ACCRETIONS

Edges of ceiling boards

- Patchy white deposits
- Tendril deposits
- Brown/white blotches
- Surface bloom
- Softwood ceiling boards

GRAPHIC NO: 12

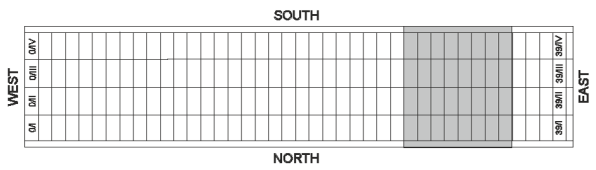
N

LOWER SIDE OF STRUCTURE

SCALE 1:50

0 1m 2m 3m 4m

POSITION Bays 2 & 3 Ceiling Panels



TITLE

PETERBOROUGH CATHEDRAL - NAVE CEILING
Conservation Programme Phase 2 (May - July 1999)

STAGE TECHNICAL SURVEY

DESCRIPTION Surface Accretions

Photogrammetry courtesy of English Heritage Survey Team & Photarc Surveys Ltd.

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APPENDICES

APPENDIX 1

List of Plates (Volume II)

1. NAVE CEILING

Plate 1 Nave Ceiling during conservation, showing the scaffolding in place for Bays 2 and 3.

2. THE CEILING STRUCTURE

TECHNICAL SURVEY:
THE ORIGINAL CEILING STRUCTURE, UPPER SIDE

Plates 2 to 25 Upper side of the ceiling before treatment. **Plates 2-7** show *Panel I* in bays *35, 34, 33, 32, 31, 30, 29, and 28;* **Plates 8-13** show *Panel II* in bays *35, 34, 33, 32, 31, 30, 29, and 28;* **Plates 14-19** show *Panel III* in bays *35, 34, 33, 32, 31, 30, 29, and 28;* **Plates 20-25** show *Panel IV* in bays *35, 34, 33, 32, 31, 30, 29, and 28.*

Noggins

Plate 26 Panel noggin in *Panel 34 II*. This noggin, or the bird's beak joint for it, first appears to the west of Joist 9 in *Panels II* and *III*, and is found in all subsequent bays in this phase of work.

Plate 27 Birds beak joint for a panel noggin in *Panel 31 II* on the west side of Joist 18.

Roof Rafters

Plate 28 An oak rafter on the south side above *Panel 31 IV* with an ancient halving joint.

Lower Ends of Sloping Ceiling Joists

Plates 29 to 33 Probable original joints at joist ends to original roof structure. **Plate 29** - south end Joist 19. **Plates 30, 31, 32** - south end Joist 12. **Plate 33** - south end Joist 9.

THE ORIGINAL CEILING STRUCTURE, LOWER SIDE

Plates 34 to 35 These show the oak dowels linking adjoining boards in the base boards; **Plate 34** shows the dowels in the open joint in *Panel 35 III;* **Plate 35** shows one half of a dowel exposed in *Panel 29 II* where the top surface of one of the boards has broken away to reveal the dowel.

Plates 36 to 39 **Plates 36 to 38** show geometric shapes made with scribes or compasses (see the centre point to the lower circle in **Plate 38**). **Plate 39** shows three freehand scratch marks crossing two boards.

Plate 40 Shows a sample board of new oak grooved with a plough plane using a single plough with a single blade which was moved twice to cut the two inner groves. Even the length of time taken to groove one board was a matter of minutes.

Plate 41 Shows a situation where two nails have been driven overlapping each other.

Plate 42 Shows a nail driven very close to the edge of a square edged board where the head of the nail has been clenched over to follow the line of the board. This would seem to indicate an importance attached to not deforming the edges of boards.

1740s / 1830s Restoration

Plate 43 Context shot *Panels 33* and *34 IV*.

Plates 44 to 46 Show the inside face of the inner parapet wall and the space between this wall and the ashlar boarding. This space is divided at regular intervals by stone plinths built to carry the cast iron shoes for the principle rafters. **Plate 46** clearly shows the rear face of the ashlar boarding covered with hessian as for the rest of the ceiling.

Plate 47 Shows where the cast iron shoe interrupts a ceiling joist, how the joist was cut back to sit on the top of the stone plinth.

Plate 48 to50 These plates show typical ashlar posts and their fixings to adjoining sloping joists. **Plate 49** shows one of the situations where the ashlar post has been cut off and has no link with the joist above at all.

Plate 51 This is a detail looking up at the end grain of the sloping joist seen in **Plate 48**.

Plate 52 This shows fragments of wood buried in the floor of the space between the ashlar boarding and the inner parapet wall. The fragments of wood were not disturbed and could either be remnants of a wall plate or merely pieces of decayed wood, which have got buried in the rubble and dirt in this area.

Plates 53 to 76 **Plates 53/54, 55/56, 57/58, 59/60, 61/62, 63/64** show the junction of the flat ceiling with the sloping ceiling on the north side. **Plates 65/66, 67/68, 69/70, 71/ 72, 73/74, 75/76** show the same junction on the south side on the ceiling. Each pair of photographs consists of one taken from directly above and one at an oblique angle. These photographs clearly show the 1926 repairs where composite joists join onto the original (see for example **Plates 63, 64 -** the joist in the foreground, and **Plates 67, 68** - the centre joist). These should be compared with much more typical 1830's repair. (See **Plates 71, 72** the upper joist, where the joint has been savagely cut apart and either not made good or repaired with fragments of timber nailed haphazardly).

Plate 77 This shows a typical 1830's repair to Joist 17 at the south end, and what is of particular interest is that the upper end of the sloping joist has been nailed to the new truss tie beam.

Plate 78 This shows a dovetail in the south end Joist 13 which is thought to be associated with earlier roof repairs and the hanging of this joist from the roof structure above.

Nails

Plates 79 to 81 These show a large rectangular nail with a rectangular head that is domed and projects more on each side than front to back. The nail in **Plate 79** has been driven into the side of Joist number 10. **Plate 81** shows similar nails attaching an additional hanger to the side of the principle rafter by Joist 9 and **Plate 80** shows another nail of similar design driven from below into a noggin above, though why this particular nail was used in this situation is impossible to tell.

Plate 82 This shows the three main types of nail used throughout the ceiling. That on the left being the original, the other two being added nails identified so far. That in the centre is what we have called a "domed" headed nail and that on the right, the "lost" headed nail. The two added nails are distinguished by the flat rectangular shank with the spear type end to the domed headed, and the much more longly even tapered shank of the lost headed nail. We have called the lost head by this name, as the head is quite small and often the nail was driven right home so that the head is actually level or below the level of the wood into which it has been driven.

Plate 83 This shows a domed headed nail that has been driven up from beneath and clenched over above at the junction of two boards.

Plate 84 This is a good example of both types of added nail which have been driven down from above. The one in the upper part of the Plate is a domed headed nail, which is the flat nail

with the spear type end, and in the lower part of the photograph is a lost headed nail with the long thin tapered shank.

Plate 85 All three types of nail head. On the left hand side are two dome headed nails, on the right hand side of the Plate, the upper nail is a lost headed nail, and the lower is an original nail.

Plate 86 This looks to be like a lost headed nail which has dropped and is assumed to have been originally driven through a patch above, but when this was taken out, the nail survived and the depth of the shank before it clenches over, would have been the thickness of the patch.

Miscellaneous

Plate 87 A fragment of slate tucked between two boards and must have been pushed there when the roof was repaired in the 1830's.

Plate 88 This shows a series of holes cut in boards. At the present time there seems to be no pattern for these holes.

Plate 89 A good example of an original board that has been moved, as no grooved boards were used for the figurative panels. Here is an example of a grooved board that has been moved and is now painted with foliage.

Plate 90 This shows a tongue and grooved ashlar board, which has been replaced in the ceiling in *Panel 31 I.*

Plate 91 An original board with a scarf which is now revealed as the adjoining board has been pushed underneath. Interestingly this repair would seem to be 1740's as there is an empty nail hole from a domed headed nail in the face of the exposed scarf. The much smaller hole for the original nail from the upper part of the scarf can be seen on the right hand side.

Plate 92 This shows a series of semicircular indentations, these are most likely to have been made from the ball of a hammer driven into the face of the board to locate it into its present position.

Plate 93 Gun shot damage. It would seem that the centre board which has the damage has been inserted into this position since the shot was fired as both adjacent boards are completely unmarked.

Plates 94-96 These plates show foundry marks on the shafts of the bolts and on the face of the washer.

Plate 97-98 The marks here would have been made by the washers when the bolts were originally being tightened. It would seem that in these two instances there was no one below to hold the bolts steady as the man above was tightening the nuts, so he has actually turned the whole bolt around causing the washers to dig into the wood.

Plate 99 Cathy Groves of Sheffield University is seen here testing edges of boards at eaves level for suitability for sampling for analysing the species of timber.

1926 Repairs

Plate 100 This shows the two methods for supporting the upper binders from the roof structure, in the foreground a wrought iron hanger can be seen bolted to the side of the double truss. One bay further back, a block can be seen as being nailed to the face of the principle rafter over which the binder has been notched.

Plate 101 The Type 3 noggin where the triangular piece is supported on top of a lamination cut to the same width (see **Drawing 8**).

Plate 102 Shows the Type 3 design in conjunction with a laminated joist, here the triangular piece can be seen to run over the bottom laminates of the joist and it will in fact be continuous on either side of the joist (see **Drawing 8**).

Plate 103 Shows an angled board as a supporting piece on the side of the joist which has been carefully notched over the individual boards (see **Drawing 7**). This photo is also of interest in showing that the upper binder is held by an iron hanger and the lower binder is notched over wooden blocks.

Plate 104 Shows an angled board fixed to a noggin which has been carefully shaped to the profile of the boards beneath (see **Drawing 7**). As this is on a sloping panel, maybe this was made as a step.

Plate 105 Here can be seen a rather crude attempt at linking two adjoining panel noggins acros a lamiunated joist. It would seem that after fixing the three flat laminates over the ceiling boards, a galvanised strap was fixed to the ends of the noggins and passed over the flat laminates. The joist was then built up over the strap. This would seem to indicate that it was thought important to maintain the continuity of the link of the two noggins across these two panels.

Plate 106 This plate is interesting because the screws have been inserted through the hessian so they can be seen. It shows that the purpose of the screws was to fix adjoining boards together because the screws run adjacent to the edges of the boards.

Plate 107-110 **Plates 109** and **110** show in detail a slither of wood already with its own covering of hessian. This piece was pushed into the gap between two adjacent boards as can be seen in **Plate 107,** the gap is clearly seen after the slither had been withdrawn in **Plate 108**. Plate 513 shows the slither of wood repositioned after treatment.

Plate 111 Hessian was **taken** up in this area as a sample for testing by UMIST. When it was taken up, a further layer of hessian was revealed beneath which was already very dirty.

Plate 112 Patches of hessian were found in this phase of works glued over the general covering of hessian. This is an example of a small patch. In other parts of the ceiling larger patches seem to have been applied, see **Plate 12**.

Plate 113 This is the same example as shown in **Plate 112** after taking the patch off. There is no evidence of major tear or loss of the original hessian to necessitate the patch except for the little cut in the hessian towards its upper edge (in this plate). What will also be seen is the black deposit, just above where the patch had been. Whether this is associated with the cut in the hessian and the subsequent patch I cannot say. If the patch was meant to be placed over this cut, then it hasn't been placed very well. The darkened area around the patch is not noticeable under ordinary lighting, and has only become noticeable in the photograph taken with flash. One assumes is the extra layer of glue applied before the patch was applied.

Plate 114 Graphic X shows areas where strips of canvas have been glued over the hessian. This plate shows some of these strips which in addition have traces of lettering, from some previous notice printed on the material. A sample was carefully detached to see why these patches had been applied, but in this case there seemed to be no fault with the hessian beneath and therefore no reason for the patch.

CONDITION

Plate 115 Here is a good example of cross checking caused by fungal decay in the grooved board without the nail in it.

Plate 116 Is an example board showing very minor signs of surface fungal decay and cross checking.

Plate 117 This plate shows typical splitting in both the original boards and the replacement boards. In the oak boards the splits all pass through nails and in the softwood board the nail is obviously what is restraining the left hand part of the board so that the right hand part has split away although the split has not gone right through the centre of the nail hole. I would suggest that all these splits have been caused by subsequent shrinkage, and are not splits from when the boards were first nailed into position. Part of the evidence for this is that other nails close to the edges of the original boards have not split the boards.

Plate 118-119 These two plates show the effect of nail heads on the subsequent appearance of the surface of the timber. In **Plate 118** a deeply striated surface is minimised beneath the nail head, and in **Plate 119,** the segment of wood in the band of the grooved board that would have been raised is now only raised where it was protected by the nail head. The timber on either side has reduced in height.

1999 PHASE II REPAIRS

Plates 120-123 This sequence shows the repair of an area of an original board which had been seriously broken out from above with large fragments of wood pushed downwards but luckily still attached. **Plate 121,** shows the fragments of wood in their existing positions protected by tissue. **Plate 122** shows a prop in position with softening to hold the fragments whilst the glue was curing. **Plate 123** shows the same area after repair.

Plates124-127 In **Plate 124**, Cameron Stewart is seen preparing to undo a hanging bolt assisted on the left by Bob Chappell. **Plate 125**, shows Bob Chappell stopping the bolt from twisting using the walky-talky to keep in touch with his colleague above who is loosening the bolt. In **Plate 124**, the joist carrier can be seen in position clamped to the joist from which the hanging bolt is about to be taken out. **Plate 126**, shows Bob Chappell carefully passing up a temporary bolt having taken out the original bolt and **Plate 127**shows an original hanging bolt back in position with Plastazote packer beneath the washer.

Plate 128 Shows the centre of the ceiling with the walkway taken out and the joist carrier in position having just exchanged a number of original bolts for temporary ones.

Plate 129-130 **Plate 129**, is an example of a screw that has pushed down a sliver of wood from the edge of a board. **Plate 130**, shows the same situation after the screw has been withdrawn.

Plate 131-134 This sequence shows the system for locating and extracting screws which have penetrated below the underside of the ceiling. In **Plate 131**, Bob Chappell is locating a screw with a circuit tester which has a built-in bulb so that as soon as the screw which is already attached to the other end of the circuit with a crocodile clip is touched by the probe, the bulb lights up indicating that the correct screw has been located. **Plate 132**, Clare Cully is helping to locate screws by measuring from existing ones that have already been located. In **Plate 133**, Bob Chappell is extracting the screw that has been identified, and **Plate 134** shows the old screw placed on the hessian next to the new screw to be inserted, and the circuit breaker and the metal detector used to locate the screws.

Plates 135-137 These plates show typical stainless steel fastenings used to repair the ceiling boards. In **Plate 135**, the left-hand softwood board has been attached with two stainless steel angles and two screws with washers all of which have been touched in on completion of work. In **Plate 136**, a single stainless steel angle can be seen through the hole in the original board before retouching. The white strip halfway up on the left-hand side of the same board is a piece of tape to hold a splinter in position whilst the glue cures. **Plate 137**, shows two stainless steel screws and washers in position before retouching.

Plates 138-139 **Plate 138** shows stainless steel screws replacing old steel screws and a single angle with nuts and washer can be seen above the hessian. **Plate 139** shows where the upper surface of the board was unreliable, so the stainless steel angle has been located through a softwood wedge and bolted above this.

Plate 140 Shows Jonathan Porter taking out steel screws from 1926 noggins and exchanging these for stainless steel. These screws did not penetrate through to the underside of the ceiling but were exchanged merely as good practise to reduce the overall number of steel screws in the structure.

Plates 141-142 Show two softwood patches where large numbers of steel screws were exchanged for stainless steel before they were covered with sail cloth.

Plate 143 Shows patches of sail cloth being attached.

Plate 144 Shows completed areas where screws have been extracted and exchanged for stainless steel and subsequently covered with sail cloth patches.

Plate 145 Shows a typical splinter in a softwood board after the screw has been extracted but before the splinter has been refixed.

Plate 146 A splinter has been refixed in the black area in the board in the centre of the photograph.

Plate 147 Paraloid based fillers have been placed in edges of boards which have been previously consolidated with Paraloid B72. These areas were subsequently retouched

Plates 148-154 This shows the various stages in making good the patch in this part of the ceiling. Note that the boards have been purposely cut to leave the thickness of a saw cut between the new and original boards. Note also how the boards have been fixed with stainless steel screws from both below and above**. Plate 150** shows Bob Chappell planing down one of the boards during preparation. **Plate 154** shows the completed repair.

Plates 155-157 These show the sequence of repair and making and retouching a new patch.

Plates 158-160 These show an area where two patches were required one in the base board and one in the board below that with the scarf.. **Plate 158** shows the situation before repair and **159** shows the two patches in position and **160** after retouching. Note that the board with the scarf was not repaired as the hessian above it could be retouched so that the overall pattern was not in anyway altered by the loss of timber.

3. THE PAINTED DECORATION

CONDITION SURVEY AND TREATMENT RECORD

Plates 162 to 321 Sections of the Ceiling structure lower side and painted decoration in before and after treatment sequence. Refer to Plate Reference Sheets for locations.

Plates 322 to 337 Sections of the Ashlar boards and painted decoration in before and after treatment sequence. Refer to Plate Reference Sheets for locations.

Plates 338 to 377 The ten full figurative lozenges and four half lozenges within Bays 2 and 3 in before and after treatment sequence. All ultra-violet (UV) illumination photographs taken before treatment. Refer to Plate Reference Sheets for locations.

Plates 378 to 381 Details of two figurative lozenges before treatment under incidental light UV illumination: the monkey holding an owl while riding backwards on a goat (**Plates 378/79**) and the dragon (**Plates 380/81**). This dragon has been found to be a 1740s invention. Underpaint visible in raking light indicates the original scheme had a Renard occupying only one quarter *(33 III)* of the lozenge. Not enough low relief underpaint survives within the other three-quarters of this lozenge to suggest the original subject.

VISIBLE UNDERPAINT

Plates 382 to 399 Examples of the original scheme visible in raking light beneath the 1740s and 1830s overpaint. **Plates 382, 389** show variations in the trefoil shape and end scroll design on different boards. **Plate 382** is an illustration of why the theory that these relief details were created by shallow carving is questionable. The prominent medullary rays are level with the raised trefoil shape. This suggests the softer wood between the rays has receded through decay where it was not protected by a paint layer. It is inconceivable that a carver would have only carved the lower ground between the medullary rays. **Plate 384** depicts a re-used original ceiling board with the 'bent over' trefoil design facing the wrong way joined to an original board with the more conventional trefoil design. **Plate 385** shows an additional feature to the decorative scheme, which has only become evident during Phase 2. The centre of some trefoils is embellished by a raised dot. The dots have a grainy texture and surface microflaking. Although at first thought to be part of the original design, sample analysis indicates they are an 1830s addition[1]. **Plates 386-389** depicts differing examples of the end scroll design. **Plate 390-391** show respectively red and white paint apparently protected by original nail heads (now missing). These examples suggest: (a) this paint survives from the original C13th scheme; (b) the original painted design on the grooved boards – was similar to the coloured bands boards; (c) being under original nails the grooves must have been painted before the board was fixed in place. No paint was detected on a sample taken from the 'white' groove; the red paint is a mixture of red and white lead applied directly over the wood[2]. **Plates 392 395** depict original wave, bun and stepped chevron patterns underlying the 1740s and 1830s overpaint -(the coloured bands board underpainted with stepped chevron pattern shown in Plate 395 is a re-positioned board. These original patterns are all linear in design. **Plates 396-399** show original underpaint on foliate and figurative lozenge boards. **Plates 396, 398, 399** indicate that the 1740's restorer generally followed closely the original foliate and figurative designs: the lozenge detailed in **Plate 397** being the sole exception identified to date. Here raking light defines the head and neck of a fox in low relief beneath overpaint. The fox occupies only one quarter of the lozenge. This image also illustrates the way the wood surface of the background has decayed: the softer part of the growth rings being more affected and thus resulting in a ridged surface.

1740S/1830S REPAINTING

Plates 400 to 405 Examples of the paint layer exposed from under temporally removed 1830s Ceiling bolts and washers The 1740s paint has been protected from subsequent overpaint and surface accretions. These examples indicate the condition of the painted decoration immediately prior to the 1830s intervention and provide visible confirmation of the analysis findings and our interpretation of the conservation history. The patch of red paint revealed in **Plate 400** has been identified through analysis as belonging to the 1830s restoration.[3] **Plate 401 and 402** show the Prussian blue, 1830s paint overlying the gritty textured, olive green copper bearing pigment of the 1740s. **Plates 403-405** as well as showing the exposed 1740's paint illustrates the extent of discoloration resulting from surface accretions since the 1830s. In **Plate 405** it is just possible to see a bright white edge of the 1830s white lead background overpaint where it had been brushed under the rim of a ceiling bolt washer.

Plates 406 to 409 Details of visible underpaint on replacement or displaced boards. **Plates 406 and 407** show crudely painted key pattern design on softwood boards. Very few examples of this carelessly applied underpaint on softwood boards exist in Bays 1 – 3. No paint samples have been obtained from these examples but the type of board and the quality of the underpaint point to an 1830s date. In **Plate 408** the coloured bands design shows faintly through the white background paint also on a softwood board is thought to be 1830s. This board has a characteristic general bloom, which has the appearance of a coating of white dusty material noticeable on many of the 1830s replacement boards. **Plate 409** shows linear stepped chevron underpaint on a replacement oak board. In **Plate 410** two layers of

[1] *Peterborough Cathedral Nave Ceiling Paintings: Scientific Examination Phase 2* Dr Ioanna Kakoulli, December 1999. Sample 8 (pls. 18-20).
[2] Kakoulli 1999: Samples 26 and 57
[3] Kakoulli 1999: Samples 22

wave pattern are visible on the slightly displaced original board. This finding is an anomaly and calls into question the hypothesis that the wave pattern boards were not overpainted in the 1740s intervention. Paint samples were not obtained from this board so we cannot rule out the possibility that this underpaint dates from the 1740s intervention. However, sample analysis has identified one example of an original wave pattern board with two layers of 1830s decoration[4] and this may be another instance.

Plate 411 The grey chevron board is a 1740s softwood replacement. It is exceptional for having a curved edge and because the grey chevron design was not overpainted in the 1830s. From Row 34 westwards the 1730s 'leaf' or V shaped embellishment (detailed as impasto underpaint in Plate 429) has been replaced by the 1830s white dashes (see also Plate 429 and 430).

Plates 412 to 417 A series of three details photographed in incidental light and UV illumination showing how UV light enhances the difference between the restorations. The 1830s white paint appears as a brown wash in Plates 413 and 417. In Plate 415 the 1830s red paint appears much lighter than the 1740s red under UV illumination.

Plate 418 Analysis of the bright blue-green paint surrounding the empty nail hole was inconclusive[5]. The 1830s restorers may have applied it when the original nail was removed.

Plate 419 An unpainted scalf joint. It is not clear why this joint was left unpainted.

Plate 420 An 1830s softwood replacement board with a thin reddish-brown setting out line. Such setting out lines appear to have been used for lining up painted decoration in the few instances where one wide replacement board has been used to replace more than one original board. These lines were not noted in Bay 1. The paint on this obviously 1830s softwood boards has a characteristic milky or silvery surface sheen. Analysis indicates this is a thin pale coating as yet unidentified. It does not respond to surface cleaning with Wishab sponges.

Plate 420 also depicts loosely adhering dust found where drafts have deposited material. This happens where there are gaps or voids in the ceiling allowing air movement between the nave and the roof space above before the hessian was applied in 1926.

BLACK PAINTS & SURFACE ACCRETIONS

Plates 421 to 423 During this phase close attention was paid to the wide variety of black paints employed by the 1740s and 1830s restorers. It was apparent that different shades of black had been used intentionally to decorate different patterns in the lozenge border pattern sequence. Paint sample analysis has identified three black paints belonging to the 1740s scheme and four belonging to the 1830s restoration. **Plate 421** depicts: a key pattern board with 1740s brown/black strengthened with a lustrous black layer with red and yellow inclusions; a wave pattern board with what appears to be a dense 1830s black overpainted with a varnish coating with some black pigment inclusions; a stepped chevron board with 1740s brown/black strengthened with a lustrous black layer with red and yellow inclusions. As an illustration of the seemingly arbitrary way in which the 1830s restorers worked, **Plate 422** shows the same sequence of boards with the 1740s brown/black key pattern not overpainted, the wave pattern with only the dense, matt black 1830s layer and the stepped chevron pattern overpainted as in the previous photograph. **Plate 423** is a detail of a stepped chevron with the 1740s brown/black overpainted, in this instance, with the 1830s brownish matrix of brown and yellow iron oxide particles combined with brilliant yellow and black. Generally, it is mainly the stepped edges that are strengthened, rarely is the whole pattern overpainted.

[4] *Peterborough Cathedral, nave ceiling: Scientific examination of the original decoration of Bays 36-39* H. Howard September 1998. Sample 19

[5] Kakoulli1999: Sample 28

Plates 424 to 427 **Plate 424** shows under raking light very characteristic efflorescence like a drawn chalk line only found on boards decorated with the wave border pattern. The chalk line follows the shape of the decoration, and occurs in the off white colour. **Plate 424** also illustrates microflaking of the deep, velvety black paint of the wave pattern. This type of damage is associated only with this type of black paint and occurs only on the wave pattern. Visual examination suggests that the microflaking has occurred where there is a single layer of paint and no preparation layer. Samples obtained of this type of black paint (but without microflaking) had a more than one layer of paint[6]. **Plate 425** shows a detail of wave pattern with apparently a layer of microflaking, black paint directly over the wood: this layer is partly covered by a varnish coating with some black pigment inclusions. Plates 426, 427 were taken with raking light pointing towards the camera to enhance the surface shine produced by the varnish coating with some black pigment inclusions. The brush strokes demonstrate that it is a separate layer unlike the thick resinous black paint/ coating associated with patchy white surface accretions shown in **Plates 428, 430**.

Plates 428, 431 The patchy white surface accretions associated with the thick resinous black paint/ coating remain unidentified. These were considered to be some form of microbiological growth (MBG) but analysis by Dr Brian Ridout[7] indicates they are accumulations of irregularly shaped translucent, plate-like crystals.

Plates 432 Detail of paint shrinkage cracks associated exclusively but only very rarely with 1830s black paint on softwood replacement boards.

Plates 433 to 434 In addition to the with patchy white surface accretions, initially considered to be MBG, Ridout was asked to sample and analyse three other categories of surface accretion. Only the tendril deposits (**Plate 433**), which resemble miniature spider web, joining larger elements together, may have originated through microbiological action: some collapsed strand material was found. The other categories - brown spots and brown blotches (**Plate 434**) – are described by Ridout as of irregularly shaped translucent granules. These accretions are widespread across the Ceiling.

REPLACEMENT BOARDS WITH FRIEZE DECORATION UNDERPAINT

Plates 435 to 438 Examples of softwood replacement boards, which have as underpainting the bold on the Ashlar boards. **Plates 436 to 438** are details of a board that appears to have the 1740s composite black paint covering the floral scheme. A paint sample has been obtained from this board and will be analyses during Phase 3. The analysis will concentrate on identifying barytes as a component of the white background paint. If barytes were not present it would add weight to the current theory that these replacement softwood ceiling boards with the frieze decoration as underpaint were inserted during the 1740s restoration.

1880S REBUILDING OF THE TOWER & GRAFFITI

Plates 439 to 445 Findings during this phase suggest that the nave was screened off during the rebuilding of the tower in the 1880s. **Plates 439 and 440**, taken before surface cleaning, show a band of thick dirt across the ceiling boards in Bay 2, Row 32. This coincides with vertical strips of masking tape adhered to the north and south Ashlar boards (**Plates 441 and 442)**. **Plates 443 and 445** show the strip of masking tape on the north side being removed - the tape was wetted to soften the adhesive – and the residual adhesive following removal of the tape. The residue was later removed using damp swabs. **Plate 445** shows fragments of the tape after removal.

Plate 446 Detail of graffiti written in pencil onto a ceiling board immediately to the east of the dirt band on *Panel 33/II*. The graffiti reads '*Wm George Higgs January 16 1883*'. No graffiti was found to the west of the dirt band on the ceiling boards; although on the Ashlar boards in Bays 1, 2 and 3 there are a number of examples dated 1890. This graffiti on the Ashlar boards records that limewash was scraped from the nave walls during 1990. As no

[6] Kakoulli1999: Samples 45 and 46
[7] Dr B Ridout. Unpublished letter to J Limentani, 16 June 1999.

1990s graffiti exists above the frieze it is likely that the workers did not have access to the ceiling boards at that time. By intention the examples of pencilled graffiti were not removed during surface cleaning.

ASHLAR BOARDS

Plates 447 to 456 A series of details photographed in incidental light and UV illumination showing the underpaint that exists on the north and south Ashlar boards from Row 34 westwards. This first scheme is significantly different from the overpainted design. We are now certain that the Ashlar boards and the visible frieze decoration date from the 1830s. One theory to explain the existence of the underpainting in Bays 1 and 2 is that this initial design did not meet with approval. Having begun work at the east end the painters were required to start afresh.

Plate 457 Detail of a small section of Ashlar board immediately above wall plate level showing an area of exposed pink underpaint. This pink underpaint is not overall but exists sporadically in small areas beneath the 1830s scheme on both the Ashlar and ceiling boards.

Plate 458 Detail showing fragments of red and blue-green paint found immediately below the wallplate on a stone arch moulding of the north wall in Bay 2. The scheme was on limewash covering the stone. It must have been scraped from the walls in 1890.

WATER DAMAGE AND STAINING

Plates 459 to 466 Sections of the Ashlar boards within Bays 2 and 3 had been considerably affected by water infiltration. **Plates 459 and 460** show an area of water damaged frieze decoration before treatment in incidental light and UV illumination. **Plates 461 - 466** depict areas during and after treatment to remove water stains. The treatment process involves surface cleaning with Wishab sponges, removal of the stains by localised swabbing with deionised water and finally, toning out with water-colour paint the 'blanched' or 'cleaner' areas of decoration resulting from the stain removal.

Plate 467 to 475 There are a number of different categories of staining, all resulting from liquid material penetrating down between the boards or through cracks in deteriorated boards. **Plate 467** depicts an example of a stain from a clear liquid that has penetrated a replacement board. This category of stains resembles paint saturation: they are not overly distracting and therefore were not treated. The same image depicts staining of the paint over a knot in the wood. This is found on softwood boards only and is sometimes accompanied by resin drips from the knot. **Plates 468-470 (UV)** show a dark stain over the 1830s repaint before and after reduction: acetone was the solvent used. Analysis of a sample from a similar stain in Bay 1 indicated the presence of shellac in the stain material.[8] It is likely a preservative material used to coat roof timbers caused the stain. **Plates 471 and 472** shows a large lighter brown stain before and after reduction. **Plate 473** shows the same area during toning down of 'blanching'. The brown stain shown in **Plate 345** has come through the thickness of the paint. **Plates 474 and 475 (UV)** show characteristic light-brown drips on the edge of an original board. These are prevalent across Bays 1, 2 and 3. The material having dripped through holes and splits in the boards and around boards edges.

SURFACE GLUE

Plates 476 & 477 Details showing typical damage caused by thick glue drips over the paint surface before treatment. The water-soluble animal glue was used to adhere hessian to the Ceiling boards upper side during the 1926 intervention. The liquid penetrated between the boards, accumulating on the horizontal board edges and in places running across the surface of the Ashlar boards and canted ceiling boards. In these examples the thick glue has contracted and detached from the surface pulling away the underlying paint.

[8] Howard 1998: Sample 11

Plates 478- 489 A series of photographs before treatment in incidental light and. Ultra-violet light is particularly helpful when checking for glue residue during the treatment process. These photographs illustrate how the glue has run across the canted panels and Ashlar boards (**Plates 479, 481, 483 and 485**) whereas on the horizontal boards it has accumulated on the edges. **Plates 488, 490 and 491** show glue drips on a curved-edged horizontal board before treatment, after surface cleaning and glue removal and after toning in of the blanched areas. Attempts to re-adhere the paint detached as a result of overlying glue contraction are not always successful. **Plate 482** depicts an example of what we describe as adulterated glue. Glue drips with a sugary/crusty texture, possibly resulting from the glue having been altered by the action of another chemical.

Plates 492 & 493 Show an example, before and after treatment, of a thin glue film across the surface of a board.

Plate 494 A photograph in UV illumination illustrating the extent of glue penetration through the gaps between ceiling boards.

FLAKING PAINT

Plates 495 to 498 Typical example in raking light of paint 'delamination' usually associated with the thick, 1740s compound black layer on stepped chevron and grey chevron and base boards. **Plate 498** shows and area of such damage on a base board being re-adhered with the aid of a heated spatula after the consolidant had been injected behind the flakes.

PAINT RE-ATTACHMENT

Plates 499 &502 Reattachment of flaking paint on metal fixings. **Plates 499, 500** show a typical example of corrosion on a ceiling bolt and washer with associated paint loss and flaking, before and after treatment. **Plates 501, 502** details of flaking paint on nail head with raking light during and after treatment. The flaking paint is infused with two applications of Paraloid B72 (10% in acetone); once the solvent had evaporated a localised heat source (Preservation Pencil) was applied to the flakes relaxing them sufficiently and enabling them to be pressed back into place with a small spatula.

SURFACE CLEANING

Plate 503 to 510 Sections of the Ceiling decoration during surface cleaning using Wishab sponges. This method of cleaning without the use of solvents achieves a uniform and acceptable cleaning level without causing the paint surface to shine.

DISGUISE OF WOOD LOSS

Plate 511 An area of wood loss revealing the hessian backing. The light brown hessian colour was noticeable from ground level so has been disguised with black acrylic paint.

ENVIRONMENTAL MONITORING

Plate 512 A surface temperature probe attached to the panel 33 III. This has been left in place to record the effect of solar radiation on the back of the ceiling from the roof lights[9].

STRUCTURE

Plate 513 Shows the slither of wood depicted in **Plates 107** and **108** repositioned after treatment.

[9] *Peterborough Cathedral: Environmental Monitoring of the Nave Ceiling. March 1998 – January 2000. Preliminary Report.* Tobit Curteis Associates. (Page 4).

APPENDIX 2

Panel No: 29 III

DESCRIPTION							JOINTS				DAMAGE							TREATMENT				
					Soft wood		Scarf			Butt	Damage			Displaced								
														Vertical		Lateral						
Board No.	Tapered/Sq./ Loz./BB/T&G	Rnd/Straight/Grooved	Orig/Rep/Pat/Ash	Wood type: Oak/Softwood	Smooth (S)	Torn Grain (T)	Long Board mm	Scarf length mm	Scarf to	Jointed to	CFB (C)	DWB (D)	C/D Holes per 25mm sq	mm	N/S/E/W	mm	N/S/E/W	SS Fixings	Bencon 19	Plextol B500	Paraloid B72	Fills
A	L	R	O	O							C	D										
B	L	R	O	O												20/35	NE/NE					
C	T	G	O	O							C		C3									
D	T	R	O	O							C		C5									
E	T	S	O	O							C	D	C7D2									
F	S	S	P	S	S	10																
G	T	G	O	O							C	D	C5									
H	S	S	R	S	S	12.5					C											
I	T	R	O	O					J		C		C6									
J	T	R	O	O					I/K		C											
K	T	R	O	O					J/L		C	D	C2D2									
L	T	R	O	O					K		C	D	C10			40/20	S/NW					
M	T	G	O	O			2030	50	N		C	D	C8D2									
N	T	G	O	O								D	D2									
O	BB		R	O							C											
P	BB		O	O					Q		C	D	C6									
Q	BB		O	O					P		C	D	C3D2									
R	T	G	O	O					R		C	D	C8D3									
S	T	G	O	O					S		C	D	C2D4									
T	T	G	R	O			1950	90	U		C	D	C7D2									
U	T	R	O	O					T		C		C5									
V	T	G	O	O					W		C		C2									
W	T	G	O	O			2290	90	V		C		C7									
X	T	S	O	O			2090	115	Y		C	D	C5									
Y	T	S	O	O					X		C	D	C2									
Z	T	R	O	O							C		C4									
AA	T	G	O	O																		
BB	L	R	O	O							C		C9									
CC	L	R	O	O							C		C8									
DD	L	R	O	O																		

Panel No: 29 III Page 1 of 1

Board No.	Observations
A	Small amount of wood loss on E & SW edges - probably splitting around nails; moderate insect attack.
B	Surface impact damage 30cm from N end; hammer head marks round clenched nail 30cm from S end; lightly incised line 35mm from E edge possibly marking true line of joint.
C	Insect attack/tunnelling along N 45cm of W edge; some weathering & layer separation; incised line along E edge, possibly lining-up mark for B.
D	Area of wood loss on central W edge - insect attack/tunnelling; group of hammer head impact marks 60cm from N end; some layer separation.
E	Substantial areas of wood loss along W edge due to insect attack/tunnelling; small wood loss around nail hole N edge; fragments loosely attached at NE & SW corners; moderate weathering; wood loss caused by bolt washer (bolt tight up to underneath board).
F	Good.
G	Patches of wood loss along W & E edges caused by insect attack/tunnelling; shakes from S end.
H	Long shakes from S end may be due to pressure from bolt; small area of insect attack/tunnelling; NW corner has been sawn off-fragment may be pushed up behind.
I	Moderate weathering - fragile splinter 20mm from S end.
J	Some layer separation; shake from S end.
K	Set of impact marks of varying lengths 30cm from S; some wood loss from splintering & insect attack behind edge of H; lightly incised crossed lines 30cm from N end.
L	Shake from N end; slight wood loss at N end appears due to splintering because of fine taper of scarf.
M	Wood loss at S end appears to be from fracture from a shake & insect attack; wood loss at central E edge due to insect attack/tunnelling & at N corner to nailing/impact damage.
N	Some layer separation; fine clusters of hammer head impact marks of varying sizes, all around nail holes.
O	Insect attack sporadic; circular hole cut near N corner; shakes from N end; moderate weathering. Board has been laid over adjoining boards P & Q; curved incised line across S end level with end of P - lining up mark.
P	Moderate weathering; hole cut 68cm from N end.
Q	Good.
R	Slight layer separation; CFB concentrated at N end, DWB at S; small area of wood loss at NW corner due to nailing/insect attack.
S	Some layer separation; lightly incised crossed lines 15cm from N end.
T	Replacement board (grooved); insect attack/tunnelling to depth of 5cm along most of E edge; small area of wood loss & insect attack from near NE corner could be due to splitting; NE corner sawn off, possibly for original placing of board; fracture caused by nailing 60cm from S end; cluster of hammer head impact marks at S end around nail.
U	Good.
V	Wood loss from N 25cm of E edge appears due to splitting from nails & cut hole; some layer separation.
W	Area of wood loss at N end of 13cm & 21cm due to splitting & insect attack/tunnelling; some layer separation.
X	Moderate weathering; small area of wood loss at SE corner due to split - insect attack/tunnelling extending along board edge; loose splinter at S end supported by nail; some wood loss due to insect attack towards N end of W edge - loose splinter; insect attack/tunnelling on last 30cm of NE edge.
Y	Moderate weathering.
Z	Good; three clusters of hammer head impact marks near nails; series of short, straight impact marks 45cm from N end.
AA	Some weathering & layer separation; lightly incised crossed lines 13cm from N end; groups of hammer head impact marks near nails.
BB	Moderate weathering & layer separation; small area of wood loss at S corner due to splitting from nail.
CC	Moderate weathering & layer separation; S corner split off; split out E edge with some insect attack/tunnelling; shake.
DD	Moderate weathering; shakes; considerable layer separation in NW corner.

APPENDIX 3

Panel Number: 33 III **Page 1 of 1**

Board No	Pattern	Replacement Y/N	Visible Underpaint	Observations on Painted Decoration
a	Central Lozenge dragon	N		Glue drips from west edge running onto west side of front face and causing some flaking/peeling. White efflorescence around ceiling bolt. Bloom on blue/green paint. Small black/brown stain in middle part of west edge.
b	Central Lozenge dragon	N	Original underpaint	Spotty bloom on blue/green. Small brown shiny blown drip trails at west end. General white blotchy MBG. Thick dusty deposits at west end. Crudely inserted.
c	Central Lozenge dragon	N	Original underpaint	Three noticeable glue areas:- 1. West edge above dragon eye. 2. & 3. Through split in middle of board. A little flaking/peeling. Patches of bloom in blue/green background. A lesser glue area by dragon ear. Brown/black stain at east side middle, small, adjacent to that in board 'a' above. A lot of visible underpaint, possibly head & tail of dog/fox.
d	Key	N		Thick dusty deposits at south end - blown in from adjacent gaps. Split at south end has glue in split sides, some beginning to show on front face; also a small brown stain. Glue drips along west edge with associated peeling/flaking paint. In the grey of the pattern, brown spots of MBG. Noticeable strengthening of key pattern in small area at north end.
e	Key/wave etc.	Y S		A crudely inserted and painted board with pattern elements from key/wave/stepped chevron/grey chevron/extended chevron. Some of the black is in impasto with metallic sheen. Very few glue drips - but with flaking/peeling paint. Minor loss in black at west end. A splinter of wood has been lost.
f	Wave	N	S W	Possible traces of scroll at north end of board. Brown stain middle of west edge, possibly chemical. Glue drips with flaking/peeling paint west edge south half. Black dusty deposits at south end of front face. Noticeable glue drips around dislodged section of board at south end. Two minor patchy white MBG north end. Minor glue drips through hole in middle part of board. A few small impacts in middle part of board.
g,g1,g2	Stepped chevron	N	S C	Brown stain front face, east side adjacent to corresponding stain of 'f'. Noticeable black crusty glue drips on east side - south end (possibly where glue has been contaminated with another material). Group of glue drips on west edge (running onto face) with flaking/peeling paint. Thick dusty deposits at south end of board. Many small instances of patchy white MBG in black. Black has shiny metallic paint - little impasto.
h	Grey chevron	N		Glue drips on west edge at scarf joint, minor flaking/peeling paint. Very minor white blotchy MBG.
I	Grey chevron	N	L	Grey drips along west edge in a few places with associated flaking/peeling paint. Glue drips on west edge, associated with some flaking/peeling paint. Patchy white MBG, minor occurrences on black. Leaf pattern visible in off-white sections. A few glue drips on front face, middle part. delaminating paint on 'i' at junction with 'i'.
j	Extended chevron	N	S T	Visible underpaint along length of board. Glue drips along west edge, with a considerable group about one third from north end. Glue drips have associated peeling/flaking paint. Thick dusty surface accretions on the west edge of the board at the north end, probably blown in from under side of board. More minor dust with brown drip trail on centre face.
k,k1	Extended chevron	N		Glue drips on west edge with associated peeling/flaking paint. Surface of 'k1' noticeably more dusty than 'k'. Paint loss through wood splintering at join between 'k' and 'k1'.
l	Bands	N		Bump of paint loss on west edge through to wood. Minor blotchy & brown spotty MBG on black band. Tendril MBG north end.
m	Bands	N	S	Thick dusty accretion at south end, reducing to north; blown in from 'j'. Brown spot MBG.
n	Bands	Y S		Crude patch repair. Dusty accretion at east end.
o	Base board	N	S	Some metallic sheen. Patchy white MBG, blotchy MBG. Glue drips along west edge with flaking/peeling paint.
p	Base board	Y S		Minor glue runs on west and east edges. Blotchy MBG. Thick dust at south end. Possibly some bloom at west side of board.
q	Base board	N		Thick dust over face of board. Areas of slightly metallic paint.
r	Bands	Y S		MBG - spotty & blotchy in coloured stripes. Clear stain on face at south end. Scrape mark at north end (scaffold?). A few glue drips on east face at north end, some flaking/peeling paint.
s	Bands	N		Thick dust on front face in middle area. Odd glue drip at east edge of board. Brown spot MBG.
t	Extended chevron	Y S		Some pencil lines following lines of design at north end. Metallic sheen in black. Minor brown drips at south end on east face. Thick dust on east face in middle area. Glue drips and other brown drips on east face running onto front face of board. Brown spot MBG.
u	Extended chevron	N	T	Some impact marks at north end. Traces of underpaint. Thick dust on surface. White patchy MBG. Metallic sheen on black.
v	Grey chevron	Y S		Patches of thick dust on front face, brown spots MBG. Glue drips on east edge running onto front face with some flaking/peeling paint. Blotchy whitish MBG.
w	Grey chevron	N		Insect flight holes. Patchy white and blotchy white MBG. Metallic sheen. Drip marks on east edge - possibly water.
x	Stepped chevron	Y S		Tiny shiny metallic area at scarf joint with 'y'. Minor glue drip at north end. Brown spot & blotchy MBG.
y	Stepped chevron	N	Sc	Patchy white MBG. Impact damages in paint at south end. Thick dusty area on front face at south end. Example of stepped chevron underpaint (outline) out of phase with present design. Possible photo and sample analysis. Metallic sheen.
z	Wave	N	W	Glue drips on east edge and onto front with associated flaking and paint loss. Metallic sheen on black. Thick dust deposits at south end. Brown drips/stains at west edge south end.
aa	Key	Y S		Minor brown drips on east edge. Minor brown spotty MBG in grey key lines. Dusty surface accretion on front face in middle.
bb	Central lozenge	N		Good example of crescent moon mark at north end. Crusty glue drips through split at north end, and around east edge. Dusty surface accretion in north particularly . Some patchy shiny areas at south end - not glue, not metallic - more a shiny darkish stain. Carpenters marks, three lines.
cc	Central lozenge	N		Dusty surface accretion in middle particularly. Some glue drips. Patchy bloom in green/blue, which is gritty.
dd	Central lozenge	N		Dusty surface. Gritty blue/green paint.

APPENDIX 4

Peterborough Cathedral Nave Ceiling – Phase 2
Definitions for th4e Board by Board Survey

The reason for conducting the board by board survey is to expand upon the graphic documentation where it is appropriate to do so. It is also to record phenomena not documented elsewhere and any anomalies.

Key:- F = frieze, T = trefoil, S = scroll, K = key, W = wave, L = leaf, B = bands, SC = stepped chevron.
Special note if there are dots in the underpaint, in this case draw a tiny circle above the main letter. To date dots are only associated with scroll or trefoil.
Shorthand notes in margin: P = photograph, SA = sample analysis

SURFACE ACCRETION	**PLATE NO**
STAINS	
Black/brown/clear Define the colour of the stains. Clear stains resemble paint saturation, brown and black have affected the colour of the paint layer	467, 468
Water Water staining occurs where there has been water infiltration. This is noticeable on the ashlar boards, and the walls; but less obvious on the board edges. The stains do not show up in U.V.	459, 461
Chemical Generally brown in colour, having penetrated as a result of a treatment to the boards above. One such preservative was 'Silvertown'. These stains do not fluoresce.	468
Brown drips Relatively dark in colour, not very frequent; dripping through holes, splits and around boards edges.	474
Resin Most often clear staining around knots, very rarely thick drips of resin. This is only found on the replacement boards.	467
MBG	
Tendrils Tendrils of MBG, like miniature spider web, joining larger elements together. Detectable without the aid of magnification. The tendrils appear to lie on the surface of the paint. The larger white elements are fuzzy under magnification and appear as a fine white dust on the surface of the paint.	433
Grains Purple (or mauve) grains of MBG visible as a group on the surface. Grains are distinct but they are in a group, during last phase detectable without magnification.	N/A
White patches Patches of white MBG, generally found on areas of black metallic/impasto paint. Grey centre with white halo around edge. When viewed under x15 magnification the edge consists of tiny white circles or as shards/frost like crystals.	429
Blotchy These can be either white or brown; they have a fuzzy edge. Under x15 magnification the surface does not appear disrupted, but a fine white dust is noticeable within the paint texture.	434
Spots These are generally brown. At the centre there appears to be a dark brown particle, like a grain of sand, around it is a lighter brown or off-white halo with a fuzzy edge. When viewed under magnification the centre looks like an erupted area of surface, like a mini volcano.	433

EFFLORESCENCE

Crystals
Small crystal like deposits associated with **Micro flaking**.

Brown/white
Category used in phase one, now assigned to MBG.

'Chalk line' 424
Very characteristic like a drawn chalk line and often found on boards decorated with wave or stepped chevron design. The chalk line follows the shape of the decoration, and occurs in the off white colour.

GLUE

Edge 477, 488
Drips of glue are often found on the edges of boards. These drips are excess material from when the hessian backing was stuck to the reverse of the boards. They clearly fluoresce in U.V. light.

Face 492, 476, 484
Glue drips can be found on the face of boards. This occurs where glue has penetrated through knots, holes or splits. Occasionally glue might penetrate from the lap over from one board to another.

Adulterated glue 37
Glue drips with a sugary/crusty texture, possibly resulting from the glue having been altered by the action of another chemical.

SURFACE DEPOSITS

Thick dust 420, 440, 439
Loosely adhering dust is found where drafts have deposited material. This happens where there are gaps or voids in the ceiling allowing air movement between the nave and the roof space above.

Compacted
Compacted accretions of dust that have build up on the surface. They resist removal with a 'Wishab', and appear to have been caused as results of penetration of another material e.g. water.

PAINT
BLOOM

General bloom 408
Particularly noticeable on the replacement boards. The boards appear to have a coating of white dusty material.

Sporadic
Patches/zones of bloom, less than general/overall.

GRAFFITI 446

Any marks, written or otherwise, in paint or in pencil.

VISIBLE UNDERPAINT

Note pattern and any anomalies. Check all boards including grey chevron, some of which have impasto underpaint beneath present off white layer.

If wave or stepped chevron is encountered note whether or not it is in phase with the overpaint. 395

If trefoil or scroll is encountered look out for dots. These are found in the centre of the trefoil 'leaf', and within the cusps of the scrolls. 385

DAMAGE

Wet rot 115
A very characteristic damage where there has been wet rot decay. The surface of the paint looks like alligator skin, and follows the decayed structure of the wood.

Micro flaking 424
To date found only in the black areas of wave pattern. The black is matt and saturated. The flakes are very small.

Flaking 495
Larger flakes of paint, cased by a number of factors. The most extreme examples are found where glue has affected the surface of the paint.

Delaminating 116
Often found in black areas; especially the base boards, stepped chevron, grey chevron. The paint often delaminates in a regular rectangular pattern not that dissimilar to the wet rot pattern.

Peeling 477
This happens where paint has been severely affected by glue drips. Glue drips can hang from the surface on a length of peeled paint.

SURFACE QUALITY

Metallic sheen 495, 378, 412, 85, 425

Only occurs on black paint; especially on the stepped chevron, and to a lesser extent on the wave/extended chevron/grey chevron. It would appear to relate to one of the most recent repaints. Where the sheen is most noticeable the paint is in impasto. This paint fluoresces mauve in UV light.

Gritty 401
This paint looks like it might be friable/powdery, but it is relatively secure and withstands cleaning with a 'Wishab'. Gritty paint is generally found in the central figurative lozenges, and is noticeable without the aid of magnification.

Impasto 429
Mostly associated with the black shiny metallic paint. The impasto varies in thickness, generally thicker on the edges of the design. It is also associated with off-white areas of the grey chevron pattern where the 'leaf' underpaint can be seen.

POWDERING PAINT
Powdering paint has not been encountered this phase so far. Last phase it was found on the canted ashlar boards at the east end. 'Wishab' cleaning removed the paint.

Shrinkage cracks 432
These occur where the paint has shrunk and crazed. To date only found on replacement boards, and very infrequent.

PAINT ABSENCE

Board alignment
Where boards have not been repositioned properly, leaving zones of bare wood along edges and/or ends of boards.

Insect damage 434, 35, 389
Where wood boring insects have attacked boards causing paint loss. In some places sections of

board have been lost through insect damage.

Flaking 497
Losses in the paint layer from flaking paint.

Other (define)
Explain what you see.

PATTERN SEQUENCE

Mistakes 162
Where the decorative order of the painted boards has been incorrectly altered. An example of this is the hammer head instead of the key on panel 36I.

Alterations
Where there have been definite alterations to the order or pattern of the painted boards. Look out for this in the off white triangles within the grey chevron pattern (35/I – 32/I). Change in 'bun' shape across N & S. Lack of base board (30/I).

In the case of the grey chevron pattern note the visible underpaint and the visible paint, with the difference between the two in the site notes book.

MECHANICAL DAMAGE

Shot 409
Damage from lead shot fired at the ceiling.

Scrape
Damage from previous actions, including that caused from erecting the scaffold.

Impact 386, 411, 92
Damage from blows to the surface of the boards.

STRUCTURE

INCISION LINES
For painting 435
The only known example so far was on the replacement ceiling board with frieze decoration underpaint.
FOR CONSTRUCTION 37, 39, 446
As described above under Incision Lines. Note probable reason for each mark (e.g. carpenters mark; circular/semi-circular/crescent alignment grooves; incision to mark line of joist; to outline painted decoration etc.). They will be plotted also on the graphics.

PHOTOGRAPH AND SAMPLE ANALYSIS

If it is a good example, discuss with others, and note it for photography. Note it by putting a mark beside it in the margin and by underlining the actual note.
If the phenomena is worthy of analysis, discuss the point with others and mark it in the margin.

DAMAGE TO THE WOOD

The reason for conducting the board by board survey is to expand upon the graphic documentation where it is appropriate to do so. It is also to record phenomena not documented elsewhere and any anomalies.

Insect Infestation Categories 434, 389, 35, 143, 136

Moderate = Even spread of exit holes but at no point as much as 2 per 25mm sq.
Light = 2 per 1 ft length

Sporadic = 1 per 1 ft length
Negligible = 1 per 2 ft length
For anything less - state number of exit holes on board.

Softwood Boards 129
Finishing of softwood boards – technique (e.g. sawn board) 90 (T & G)

Fracture 143
Fractures in the boards as opposed to splits. Fractures will normally be characterised by being breaks across the grain rather than parallel to the grain. Note the probable cause of the fracture (i.e. board weakened by insect/distortion/pressure/decay).

Cross Checking 116

This phenomenon can be recognised by a number of small fractures adjacent to each other, either along the edge of a board, or at random within an area of a board. There will always be a number of fractures and some may run parallel with the grain. They will all be much the same size, probably approx. 10mm in length. It is always associated with surface decay. See also **Surface Decay,** where the surface is merely soft but not cross checked.

Scoring 38, 36, 37, 39, 486

As described above under Incision Lines. Note probable reason for each mark (e.g. carpenters mark; circular/semi-circular/crescent alignment grooves; incision to mark line of joist; to outline painted decoration etc.). They will be plotted also on the graphics.

Wood Loss 35
Wood loss will be plotted on the graphics but note on the board by board survey the probable cause of each loss (e.g. insect attack; wet rot; loss resulting from a split/fracture in the board; hole made for construction purposes). Do not include nail holes.

Surface Decay 433
Where the wood surface is soft probably due to wet rot. This tends to be associated with paint flaking and/or loss; particularly where there is the thick brown/black 1740s paint.

Shot Holes. 409
Note whether the shot damage appears to be pre or post the last restoration. (Painted or not.)

Saw Cuts 206, 244
Note probable reason for saw cut.

Layer Separation of Medullary Ray on the Grooved Boards, or any other original board. 433
This a category will be marked on the graphics as surface splintering. Note also in observations.

Other Damage (Define) 386
Impact damage etc.. Note probable cause

PHOTOGRAPH AND SAMPLE ANALYSIS

If it is a good example, discuss with others, and note it for photography. Note it by putting a mark beside it in the margin and by underlining the actual note.

If the phenomena is worthy of analysis, discuss the point with others and mark it in the margin.

APPENDIX 5

Peterborough Cathedral Nave Ceiling - Phase 2: Pre-Treatment Condition Survey – Boards

HEADING	CRITERIA
DESCRIPTION	
Board No.	This is the number on the graphic.
Tapered/	These are boards which are tapered in section, made by splitting radially off a log. Only the original oak boards will be in this category. See Figure 3 in the first Report. Enter "T"
Square/	This covers all boards which are square in section, which covers the base boards*, the softwood boards, and a few oak patches. If the softwood boards have subsequently been shaped to a taper or part taper, this should be recorded on the back of this sheet. See Figure 3 in the first Report. *These are the flat boards which delineate each lozenge, and in the flat ceiling comprise three boards, a single board at the narrow end, which is scarfed over two boards at the wide end. The two boards are butt jointed and fixed with dowels. Where the dowels can be seen, mark them on a graphic, and if the whole length of a dowel is exposed, record the length on the reverse of this sheet. Enter "S", or "BB" if it is a base board.
Loz.	The lozenge boards are those in the centre of the lozenge, which have been worked so as to create boards which when placed next to each other provide a "flat" surface to paint figurative features. See Figure 3 in the first Report. Enter "L"
Rnd/	See Figure 3 in the first Report. Enter "R"
Straight	See Figure 3 in the first Report. Enter "S"
Grooved	See Figure 3 in the first Report. Enter "G"
Orig/	Original oak board. Enter "O"
Rep/	Replacement softwood board. Enter "R"
Pat	Patch in either softwood or oak. Enter "P"
Wood type	
Oak/	Identify by the character of the grain. Enter "O"
Softwood	Identify by the character of the grain Enter "S"
Softwood	
Smooth (S)	These boards have clean blemish free surfaces.
Torn Grain (T)	Some of the softwood boards have been poorly prepared before being fixed in the ceiling. This is mostly manifested in torn grain where no attempt has been made to change the direction of planing the wood when the direction of the grain has changed. This tears out the grain. If a board has a sawn surface which is completely unprepared, note this on the reverse of this sheet.

HEADING	CRITERIA
JOINTS	
SCARF	
Long Board	Where a single mould has been made up in length by scarfing two or more boards together, measure the length of the longest original board in mm including the shamfered end if it is the under joint . This is to ascertain a possible pattern of supply the original boards to certain set lengths.
Scarf Length	Measure the length of the scarf joint. Where the joint has pulled apart, only measure the length of the shamfer that has been worked at the end of each board.
mm	Length in mm
Scarf to	Insert the number of the board with shamfered end beneath. In the case of the base boards, insert the numbers of both boards to which the single board is scarfed.
BUTT	
Jointed to	Only inserted patches or replacement boards will be butt jointed, except the base boards which need not be entered here. Enter the number of the board to which this one is butt jointed.
CONDITION	
Insect Damage	
CFB (C)	Common furniture beetle.
DWB (D)	Death watch beetle.
C/D	Common furniture beetle and death watch beetle.
Holes per 25 mm sq.	Enter the maximum number of holes per 25 mm square using the template provided, and if the board has both infestations, indicate with (C) or (D) which type of infestation has been measured.
Displaced	
Vertical	
mm	If this board has been displaced vertically, enter the distance here in mm.
N/S/E/W	Enter which end or side of the board has been displaced.
Lateral	
mm	If this board has been refixed or moved out of alignment, enter here the distance it is out of alignment.
N/S/E/W	Enter here the direction it has been moved or refixed.
TREATMENT	
Fills	
SS Fixings	
Bencon 19	
Plextol B500	
Paraloid B72	

APPENDIX 6

Sheet # ii	**PETERBOROUGH CATHEDRAL**	**Print Film No:** ii	
Date Started: 15.7.99	**NAVE CEILING: Phase 2 (1999)**	**Film Type:** REALA	
Date Completed: 27.7.99	Comments:	**ISO:** 100	
Cameras: **Canon EOS1000 FN** ~~**Olympus OM1N**~~	**APPENDIX 6**	**Slide Film Nos:** 35,36,37,38	
		Slide Film Nos: **Film Types:**	
Flash: Cobra 700 AF		**Film Types:** PROVIA **ISO:**	
		ISO: 100	

	Frame Nos. Print	Slide	Location/Description	Flash Position Height	Orientation	Distance	Flash Setting
35	36A	37,36,35,34	28 III b WOOD FRACTURE – FACED UP		ON ARM		TTL
	36	33,32,31	ASHLAR 32/33 IV – AFTER CLEANING		"		"
	35	30,29,28,27	28 III b – WITH SUPPORT BATTEN		"		"
	34	26.25.24.23	31 III d – SPLINTER : AFTER SCREW REMOVED		"		"
	33	22.21.20.19	33 III – F.E.D. REPAIR PANEL REMOVED		"		"
	32	18.17.16	31 III – DURING STAIN REMOVAL		"		"
	31	15.14.13.12	B.C. PLANING REPLACEMENT PANEL		"		"
	30	11.10.9.8	33 II F.E.D. WITH ONE OAK PATCH INSERTED		"		"
	29	7.6.5.4.	" " WITH 2 " " "		"		"
36	28	3.2.1.37	" " " PATCHES IN PLACE		"		"
	27	36.35.34	30 II FILLS BEFORE RETOUCHING		"		"
	26	33.32.31.30	33 III SSR FIXINGS	4'	E	2'	"
	25	29.28.27.26	29/30 II – SSS	4'	E	2'	"
	24	25.24.23	33 IV ENVIRONMENTAL MONITOR	4'	E	4'	"
	23	22.21.20	VISIBLE UNDERPAINT – ASHLAR BOARDS 33 – 33 IV	4'	E	4'	"
	22	19.18.17	31 II (S.CHEV.) LOSS OF PAINT THROUGH FLAKING	5'	S	8'	"
	21	16.15.14	31 III d – AFTER CONSOLIDATION OF SPLINTER	4'	N	4'	"
	20	13.12.11.	MEDULLARY RAY (DUPLICATING S31/28) 34 III	6'	W	4'	"
	19	10.9.8.	EG. OF SPLITS : 34 III	3'	W	3'	"
	18	7.6.5.	EG OF IMPACT DAMAGE 34 III	5'	S	8'	"
	17	4.3.2.	EG OF SQ. & FLAT NAILS : 32 IV t	4'	N	5'	"
37	16	1,37.36.35	INTENDED WOOD LOSSES 32 III		ON ARM		"
*	15	34.33.32.31	28 III b – AFTER TREATMENT (C/F 37, 35)		"		"
	14	29.28.27	AFTER GLUE REMOVAL 34 III (C/F 5/0)		"		"
	13	26.25.24	AFTER STAIN REMOVAL 29 IV (C/F 7/12)	1'	W	4'	"
	12	23.22.21	AFTER RETOUCHING 28 II (C/F 9/19)	2'	S	3'	"
	11	20.19.18	AFTER TREATMENT – S.ASHLAR (C/F 10/17) + 11/36	3'	N	5'	"
	10	17.16.15	AFTER RETOUCHING – S.ASHLAR (C/F 10/16)	3'	N	5'	"
	9	14.13.12.11	AFTER SCREW REMOVAL – 31 III (C/F 10/4)	5'	N	4'	"
	8	10.9.8.	AFTER STAIN REMOVAL – 33 IV (C/F 9/14) # 1/28	5'	N	2'	"
	7	7.6.5.4.	FED TEST & ROUTING TEST	4'	W	2'	"
38	6	3.2.1.37	FED – 1ST. COAT RETOUCH	3'	S	5'	"
	5	36.35.34.33	WOOD DAMAGE & FIXINGS 28 I	3'	S	2'	"
	4	32.31.30.29	29 II x – ANGLED SHOT CRAKING	5'	N	6'	"
	3	28.27.26.25	29 II – EG OF CROSS CHECKING	5'	S	6'	"
	2	24.23.22	29 II x – EG OF SHRINKAGE	"	"	"	"
	1	21.20.19.18	33 III i – EG OF MEDULLARY SEPARATION	"	S	"	"

* SLIDE 30 = NAIL IN DOVETAIL IN ROOF. (C/F 10/10)

APPENDIX 7

Photographic Equipment and Graphics Software

Photography

Cameras	2 x Canon EOS1000 FN
Lens	2 x Canon 28-105 AF
Flash	Cobra 700 F
Slide film	Fuji Provia 100
Print film	Fuji Reala 100
Slide film for UV photography	Fuji Provia 1600

All visible light photography was carried out using the Cobra 700 F flashlight either on or off camera. Photography under UV illumination was carried out at night using 4 CLE blacklight long-wave, ultra-violet tubes (4 ft). A Lee UV2B filter together with a Hoya Haze-UV filter were used on the camera lens for all UV photography.

Software

Graphics	Corel Draw 7 and 9.
Word Processing	Microsoft Word, Version 6.
Spreadsheets	Microsoft Excel, Version 6

APPENDIX 8

PETERBOROUGH CATHEDRAL: PHASE 2
SAMPLING STRATEGY FOR IOANNA KAKOULLI SITE VISIT (24.5.99)

As the work progresses down the nave new discoveries are being made related to the decorative scheme. Sample analysis is a vital part of the information gathering process and will help inform our views on the scheme, its later additions/interventions and approach to the conservation treatments. The following aspects of the painted scheme have been earmarked for investigation during Phase 2.

ASHLAR BOARDS

Analysis of the underpaint of the ashlar boards is particularly important as the underpaint appears to stop at the join between panels 31/30 on the north side and within panel 31/IV on the south side. This may be our last chance to sample the underpainted frieze decoration. Examination under ultra-violet illumination indicates the presently visible decoration was "touched up" during the 1830s restoration but was by no means completely restored. This dates the presently visible pattern to the 1740s; assuming there were no unrecorded interventions between these dates. The frieze underpaint exists in Bays 1 and 2 only. The decoration is similar but by no means identical to the presently visible scheme. A number of paint samples should be obtained from the ashlar boards in Bay 2. Cross section analysis may help to solve the apparent anomaly presented by the frieze pattern underpaint on some ceiling boards replaced in the 1740s. Is the underpaint on these replacement ceiling boards from the earlier or later frieze scheme? A number of further points relating to the frieze decoration should be addressed:

- The white lead paint used on the ceiling boards in both the 1740s the 1830s was bright white in colour - see **Plate 303**[10] showing paint from both restorations that had been protected from subsequent surface discoloration by a hanging bolt washer. Why then was frieze decoration has been tinted overall with what may be a water-colour wash to tone down the colour of the background (see **Plate 296**) when at that time the ceiling decoration was much brighter?

- A limited number of boards within the eastern half of *Panels 39 I/II/III/IV* (no longer accessible) have white background paint very similar to that used on the frieze; for instance, the keyhole and key pattern boards in **Plate 297** appear to have been painted with the lighter background paint on the frieze and then darkened down with a tinted wash. At present we cannot explain the presence of these differently painted boards.

- Why has the paint surface on the frieze not discoloured to the same degree as the 1830s ceiling repaint?

- There is still considerable uncertainty concerning the accurate scribing of the top ashlar boards to the feet of the boards in the sloping panels, particularly if the frieze underpaint is pre the 1740s restoration and most of the softwood boards in the sloping ceiling panels were, as we now think, inserted in the 1740s. It is essential therefore, that as much information is gleaned as possible into the history of these boards from paint sample analysis.

TREFOIL UNDERPAINT & UNPAINTED BACKGROUND?

With raking light a trefoil pattern, terminating with an elaborate scroll design, is discernible under the extended chevron pattern on many original oak boards (see **Figure 6** and **Plates 286-289**). There is clear visual evidence that the overlying extended chevron design was painted in the 1740s. Sample analysis indicates that a combination of vermilion with lead white was employed to create the underlying trefoil pattern. From samples taken in 1997 Howard concluded the design was unlikely to be original as the lead white overpaint covering the pink trefoil layer appeared to have been painted almost wet-on-wet. However, her preliminary 1998 findings suggest that the trefoil design may indeed by original. Visual examination suggests that the relief effect first thought simply to be impasto paint is in many places too pronounced for the thickness of the paint. Furthermore, the impasto effect appears and fades along the boards with no evidence that some of the layer may have flaked. These observations - coupled with Howard's finding in 1997 that a similar pink layer was detected in a sample taken from an area further along the board, but where no trace of an underlying design is visible even in raking

[10] See the Phase 1 Condition Survey and Conservation Record for Plate Number and Figure references.

light - may suggest that a thin, less stable, original background paint layer may have been partially lost at an early date. The surface of the exposed areas of board deteriorated substantially as a result of environmental factors before being overpainted in the 1740s, while the protected timber under the original oil-based paint of the trefoil design was unaffected. This is just one theory that may explain the phenomenon. Further paint sample analysis is required to test the hypothesis.

Unpainted Background & Changes in Border Design

There are other examples of underpaint showing the outlines of border designs in relief on boards with otherwise 'weathered' surfaces: the black stepped chevron designs on original boards appear to be edged with exaggerated impasto underpaint (see **Plates 365, 290**); the dog tooth pattern underpaint shown in **Plates 292** appears to have been painted in outline only. In the current phase we have found examples of finely linear wave pattern, stepped chevron and bun pattern underpaint. These all appear to be part of the original scheme.

Underpaint on the Figurative and Foliate Lozenges

Within the figurative and foliate lozenges in Bays 2 and 3 there is evidence of the original scheme surviving under the overpaint. The raised designs being evident in raking light. These findings suggest that the 1740s restoration followed the original lozenge scheme fairly closely. We hope that samples taken from these areas will reveal much more about the technique and materials of the original scheme.

The White Embellishments on the Grey Chevron Border Design

The white embellishments on the grey chevron border design within the eastern bay (see **Plate 314**) differs from the equivalent embellishments within Bays 2 and 3. The “leaf” design in Bay 1 and part of Bay 2 is apparent as impasto underpaint (covered by a different design of white embellishments from 1830s) on the remaining grey chevron boards accessible during Phase 2.. Further paint sample analysis is required during Phase 2 to confirm this theory. In addition, cross section analysis of a sample from one of the few replacement grey chevron boards without the “leaf” underpaint in comparison to a replacement board with the leaf” underpaint may help in dating the boards.

Key Pattern

Overall the ceiling the 1740s repaint places the key pattern as the first in the sequence of border designs radiating out from the figurative lozenges. The key pattern is painted on the outer part of the board so covers grooving on original straight-edged boards (see **Plate 292**). It is at least questionable whether the 13-century creators would have chosen to disguise in this way the carefully constructed sequence of boards with rounded edges, straight edges and straight-edges and grooves. **Plate 293** shows a round-edged original board, repositioned and repainted in the 1830s, with key pattern underpaint visible on the inside edge. Although the date of the underpaint is uncertain and is the only example within the eastern bay of a round-edged board with key pattern it highlights another area of continued uncertainty to which only paint sample analysis is likely to find an answer.

Surface Coating

There appear to be two distinct black paint used by the 1830s restorers: a very matte and very saturated black often seen on wave or dog tooth pattern boards; a shiny black, with a metallic sheen to it. The latter may occur over a whole board or in small areas, on 19th century replacement boards and as a strengthening over 18th century black. It frequently occurs on the edges of shapes, strengthening their outlines. In 1997 Howard discovered evidence of surface coatings on two samples of this type of black paint: '*Sample(17/2109) from the stepped chevron pattern surrounding the St. Paul lozenge has a thin coating (or layer of consolidant) which produces a "metallic sheen". The silvery sheen on the surface of the paint layer in Sample (18/2110), also from the stepped chevron pattern surrounding the St. Paul lozenge, is due to a pale coating which has not yet been identified*'. Further research will be required to establish whether or not a surface coating was applied to this black paint. NB Shellac was may be present on one sample taken from a grey chevron board in 1997. Could this have been unintentionally applied when coating the adjacent black or is the shellac seepage of a timber treatment applied to the upper side?

Surface Staining

There are many small but significant areas of brown staining caused, it would appear, by deposits in the wood mobilised by water infiltration or by the residue of an unidentified treatment or coating applied to the boards from above. Sample analysis has yet to identify all the materials involved.

Microbiological Growth

Residues of what may be varying forms of microbiological growth were found on the paint surface. These residues are widespread across the ceiling and should be analysed as part of the Phase 2 investigations.

Efflorescence

The 'white chalk line' form of efflorescence depicted in **Plate 338** occurs on a number of the original, wave pattern boards with the matte, saturated, black paint from the 1830s. Localised water infiltration has resulted in extensive micro-flaking and some loss of the black paint; the off-white paint is unaffected except for this tide mark of salts efflorescence at the interface. Preliminary analysis results indicate at least two different salts are present: chloride and sulphate. Further examples of this phenomenon are shown in **Plates 365, 366, 367**. **Plate 293** shows a different example of salts on black paint. Other less characteristic forms of efflorescence occur: samples of these should be analysed as part of Phase 2.

PROPOSED AREAS FOR SAMPLE ANALYSIS:

UNDERPAINT

Ashlar decoration – 29 II x
The design is under the stepped chevron and therefore a reused ashlar board.
NB. A current thought is that the ashlar boards were erected in the 1740s, using, in Bays 1 and 2, existing painted boards (from elsewhere?). The presently visible design was painted in the 1740s and "touched up" in the 1830s. Similar, already painted boards were used to patch the ceiling. Therefore, the visible underpaint on the ashlar boards in Bays 1 and 2 must pre-date 1740; although not by much as the boards are tongue and groove.
Information required: Comparison of the paint and layer structure on the replacement ceiling board with that on ashlar boards both with and without underpaint.

Dots on trefoils (35 II g) and scrolls (35 II h).
This additional feature to the 'original' decorative scheme has only become evident during Phase 2.
The dots have a raised, gritty texture.
There is a similar single dot on the red background to the central lozenge of 33 III.
Information required: Layer structure and pigment(s); reasons for gritty texture

Stepped chevron – 33 III y
The linear design is out of phase with the visible paint. Is this evidence of the original scheme or a corrected mistake?
Information required: a sweep across the line and background on either side of the line to determine whether the line is original; whether there is surviving original background paint; whether the raised line is due to impasto underpaint alone or the sinking back of the wood surface either side of the line.

Foliate lozenge – 34 IV a & c
The design is unclear but is on a reused board. It appears to be the only example of this so far.
Information required: Layer structure; pigments; medium; date of underpaint.

Foliate lozenges – 31/32/III/IV
Apparent original designs visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Foliate lozenges – 31/32/I/II
Apparent original designs visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Figurative lozenge – 29 III b
Apparent original design of tail and harness of mule visible in raking light.

Information required: Layer structure; pigments; medium; date of underpaint.

Figurative lozenge – 30 IV v
Apparent original design of the harp visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Figurative lozenge – 32 II b
Apparent original design of the Agnus Dei staff visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Figurative lozenge – 31 I a
Apparent original design of the beast's tail visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Coloured bands – 32 IV
This is a replacement board apparently repainted in the 1740's.
Information required: Analysis of pigments may help to identify other 1740's work.

Dog tooth under extended chevron – 29 IV I
The dog tooth is inverted i.e. the bases of the tooths are uniquely on the *chamfered* edge. Is this a hastily corrected mistake or a reused board?
Information required: Pigment and layer structure.

Bun – 28 I e & 29 I u
These are the first examples of an 'original' bun scheme. The design is in outline only and very sharp, like the trefoil and scroll designs. Each bun is linked by a sharp line.
Information required: Pigments of bun and line.

Trefoil and scroll – 28 I h
An excellent example of a very elaborate trefoil and scroll.
Information required: Pigments – to check whether there is any difference between these and other trefoils.

Wave outline – 28 III e
The design is generally in phase.
Information required: A sweep across an area to identify the paint and establish whether it is an outline only or infilled. Concentrate on the edge/interface of line and background.

Grey chevron – e.g. 28 III g
An example of 1740's underpaint (?): the 'leaf' design can be seen beneath the later work.
Information required: Pigment of underpaint for comparison with sample of visible "leaf" design in row 35.

EFFLORESCENCE

Wave - Chalk lines – 35 II v
HH identified ammonium lead sulphate & sodium sulphate but said " the mechanism for the production of these salts in such distinct zones requires further investigation". This deterioration is only associated with this particular pattern and similarly, extensive micro-flaking occurs on the black waves but seldom occurs on other patterns. A fine crystalline surface is evident on the black paint.
Information required: Reasons/hypotheses for salts migration and flaking – is the pigment significant? It appears generally blacker than many other areas. Is there more than one layer of paint?

34 I I
Bright white 'chalky' patches that appear on paint other than the resinous black.
Information required: Analysis to compare with chalk line efflorescence as above.

Brown/white patches, stepped chevron – 29 III
It is unclear whether this is efflorescence or MBG. Also seen on Grey chevron.
Information required: I-D of material. Analysis of black/brown paint.

MBG

It would be useful to have a look at some areas to see whether it is possible to immediately rule out (or include) areas of doubt. It should be easier to formulate a strategy for MBG analysis after this initial sampling.
Common types:

'Tendrils' – 35 II h & 35 III x
'Brown spots' – 35 II h & 34 II h
'Blotchy' – 35 III e & 34 II r

Rare examples:

White spot disruption – 31 II y & z

White patches on areas of resinous black paint (metallic sheen) - General
These have occurred all over the ceiling so far and are directly related to the paint type beneath. It is unclear whether they are examples of efflorescence or MBG, or a component of the paint layer e.g. leeching wax. The resinous paint has a very metallic appearance and seems to date from the 1838 restoration.

GENERAL

Trefoil over medullary ray – 35 III u

- sample across trefoil and medullary ray
- sample across trefoil and background

To establish possible differences in the stratigraphy. One hypothesis has been that the background was originally left unpainted. and that the trefoils and other visible underpaint were painted on the bare wood and are in low relief.

Ashlar boards, south and north sides – general
Information required: Has a wash been applied to 'dirty down' the surface? Is the visible white background a different date from the ceiling boards? If so, date?

Surface staining, brown drips – 35 II h & 29 II
Information required: Are these likely to be deposits from the wood mobilised by water infiltration or chemical treatment residues?

Adulterated glue – 35 II m
In many areas the residue of a treatment above has mixed with the glue used to stick down the hessian and dripped through on to the face or edges of the boards, leaving a metallic, crusty deposit/drip.
Information required: What has adulterated the glue? One of the materials used in the preservation treatments above may have been 'Silvertown solution', which contains silver chloride and carbon sulphide.

Pigment alteration – 34 II b
The red paint layer has gone patchy 'grey' in places, possibly as a result of an intervention above.
Information required: Pigment analysis.

Surface sheen – 32 III a
A thin, streaky, shiny layer is visible on the red background with possible traces of MBG. This effect is usually associated only with repainted black. The appearance suggests a surface coating.
Information required: Analysis of coating.

Bloom, Dragon lozenge – 33 IV
The whole of the blue background is affected by this, suggesting a component of the blue pigment, perhaps affected by moisture, is the cause. The blue appears to be different from that of e.g. St Peter and may be the work of 1838, whereas the rest may be 1740 (?)
Information required: Analysis of pigment and layer structure.

Grooved boards on key pattern – general
A sweep across both raised and grooved areas may indicate the original colour scheme. Areas will have to be carefully chosen to allow for the fact that the ceiling was 'washed down' prior to the 1740 restoration.
A similar sweep would be useful on the other grooved boards – Grey chevron and coloured bands.
Information required: Layer structure and pigment analysis.

Grey chevron – 33 II v & 33 III v
An example of 1838 repaint on a replacement board with no 1740 underpaint, to ascertain whether or not there is any difference in the pigments.

The Perry Lithgow Partnership May 1999

APPENDIX 9

PETERBOROUGH CATHEDRAL: PHASE 2
SAMPLING STRATEGY FOR IOANNA KAKOULLI SITE VISIT (12.7.99)

This sampling strategy has been drawn up with reference to the strategy for Ioanna's first visit and her List of Samples (12 June 1999). The strategy includes additional proposals for sampling as a result of recent discoveries.

ASHLAR BOARDS

Analysis of the underpaint of the ashlar boards is particularly important as the underpaint appears to stop at the join between panels 31/30 on the north side and within panel 31/IV on the south side. This may be our last chance to sample the underpainted frieze decoration. 5 samples from the south ashlar boards were obtained by Ioanna on her first visit. Are preliminary results available? Discuss with Ioanna what additional samples will be required to answer queries on ashlar board decoration set out in Strategy 1.

In many areas on the ashlar boards a fine brown line (as thin as a spiders thread) can be found across the paint surface. The thread is associated with a pale 'tide mark' (visible under UV illumination) on the adjacent background paint surface. This is similar to the effect apparent on the background paint next to the black edged designs. Discuss with Ioanna whether sample analysis here will be worthwhile.

North side ashlar boards - There seems to be a green underpaint beneath the cream ground in the central area. It is unclear whether this was applied to mask an earlier paint or as part of the intended ground. Is there another scheme beneath the green?

Frieze Decoration on Replacement Ceiling Boards

Ioanna took 2 samples of this on her first visit. Are preliminary results available? Discuss with Ioanna what additional samples will be required to answer queries on these boards set out in Strategy 1.

Underpaint

SAMPLE TAKEN BY PLP
Sample22
29/30 III
Slide film 29 (nos. 12-9). Mule with harp. Red paint under ceiling bolt. Sample taken 30/6/99. Reason for sample, to find out if it is the original paint layer and what it is. The paint is lean, and appeared to be neither a thick or thin paint layer. The paint appears to be directly applied to the wood with no visible ground.

To further our understanding of the original scheme:

Key Pattern - 32 1 e (Photo F5 35)
Nave ceiling painting.Sample of red paint from groove in a key pattern board. The paint had been protected by an original nail head (now missing). This important find would suggest that: (a) This paint survives from the original C13th scheme. (b) The original painted design on the key pattern boards – and possibly all grooved

boards – was similar to the coloured bands boards. (c) Being under an original nail the design would have been painted before the board was fixed in place. Information required: pigments; medium; date of underpaint.

Coloured Bands - 32 II l
Nave ceiling painting.Sample of red paint from one of three original nail holes in grooves of the coloured bands board. Significance as above. Information required: pigments; medium; date of underpaint.

Grey chevron – 28.IV o
Nave ceiling painting.Sample of white (?)paint from original nail hole in grooves of the grey chevron board. Significance as above. Information required: pigments; medium; date of underpaint.

Key Pattern - 29 II d
Nave ceiling painting. Sample of black paint from groove in a key pattern board. The paint had been protected by an original nail head (now missing). Being under an original nail this paint maybelong to the C13th scheme. Information required: pigments; medium; date of underpaint.

Figurative lozenge – 34 III a
Blue/green background paint protected by an original nail head (now missing). This paint is not granular but is surrounded by the 1740's green/blue, granular paint. Information required: pigments; medium; date of underpaint. If this is found to be orginal paint it would suggest that at least the background was painted before the boards were fixed in place. This might explain the presence of carpenter's and register marks incised in some boards.

Figurative lozenge – 33 II c1
Bright copper green underneath a hanging bolt washer. The green paint escaped the 1830s repaint It has a granular texture.NB Helen Howard's 1997 samples 2/2094, 3/2095 from the Psaltery Player lozenge; also, her 1998 sample 1/2347 from a foliate lozenge. Information required: Layer structure; pigments; medium; date of underpaint.

Stepped chevron – 33 III y
The linear design is out of phase with the visible paint. Is this evidence of the original scheme or a corrected mistake?
Information required: a sweep across the line and background on either side of the line to determine whether the line is original; whether there is surviving original background paint; whether the raised line is due to impasto underpaint alone or the sinking back of the wood surface either side of the line.

Foliate lozenge – 34 IV a & c
The design is unclear but is on a reused board. It appears to be the only example of this so far.
Information required: Layer structure; pigments; medium; date of underpaint.

Foliate lozenges – 31/32/III/IV
Apparent original designs visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Foliate lozenges – 31/32/I/II
Apparent original designs visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Figurative lozenge – 29 III b
Apparent original design of tail and harness of mule visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Figurative lozenge – 30 IV v
Apparent original design of the harp visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Figurative lozenge – 33 I a
Apparent original design of the beast's tail visible in raking light.
Information required: Layer structure; pigments; medium; date of underpaint.

Coloured bands – 32 IV
This is a replacement board apparently repainted in the 1740's.
Information required: Analysis of pigments may help to identify other 1740's work.

Dog tooth under extended chevron – 29 IV I
The dog tooth is inverted i.e. the bases of the tooths are uniquely on the *chamfered* edge. Is this a hastily corrected mistake or a reused board?
Information required: Pigment and layer structure.

Wave outline – 28 III e
The design is generally in phase.
A sweep across an area to identify the paint and establish whether it is an outline only or infilled. Concentrate on the edge/interface of line and background.
***IK sample #18 only covers one area.**

Grey chevron – e.g. 28 III g
An example of 1740's underpaint (?): the 'leaf' design can be seen beneath the later work.
Information required: Pigment of underpaint for comparison with sample of visible "leaf" design in row 35.

Grooved board (Grey chevron) – 30 III x
Possible original paint – black and white (possible red traces?) lines under a lost original nail head. The paint appears to follow the groove lines, perhaps indicating the original decorative scheme.
See below '**Grooved boards on key pattern – general (NB 28 III e)'**

Wave pattern - 30 III e
Sample area at junction of white and black about 45cm from north end. In this area it is possible to see specks of red paint apparently beneath the uppermost paint layer. These flecks of paint occur where there is the line of visible underpaint. Information required: Layer structure; pigments; medium; date of underpaint.

Trefoil – eg 28 I i & 33 II u
To identify original colour/decorative surface of various trefoils. HH found carbon black & thought it may be drawing – could it be the intended colour/appearance? If the new samples are taken from the central areas of the trefoils and are found to contain carbon black, it seems unlikely that the drawing would have continued into these areas: drawing lines are usually limited to the perimeters. In the same HH sample 27/2119 she also noted that the pinkish layer extended over both the trefoil and the background. It is surely unlikely that the trefoil design would only be delineated by the slight relief. Could the pink layer be from a later date eg 1740, when the original decorative scheme of trefoils was painted out and replaced with the simpler extended chevron design – which would be considerably easier and quicker (cheaper) to repaint?
It would be useful if one of these samples (or another area) could be large enough to extend over an edge of a raised design. This may show how the different layers interface/overlay.

Dogtooth/Bun - 34 I d
A shape (possibly a malformed bun),visible in relief. Tis is the only sign of visible underpaint on this board.

GLUE

From any untreated board
A sample of 'non-crystaline' glue.
Information required: identification of glue.

Patch section on board (removed fo tr investigation) - 32 III s
A sample of both layers of hessian. This small piece of softwood board has been used to pack the vertical gap between two boards. Does the earlier hessian and adhesive date from the 1740s or 1830s restoration rather than 1924 when the reverse of all ceiling boards were covered? The earliest layer is covered in a thick layer of dirt suggesting it was in place for a considerable time before the 1926 hessian was applied overall.
Information required: identification of the glues.

EFFLORESCENCE

Wave - Chalk lines – 35 II v ***Possibly covered by IK # 21**
HH identified ammonium lead sulphate & sodium sulphate but said " the mechanism for the production of these salts in such distinct zones requires further investigation". This deterioration is only associated with this particular pattern and similarly, extensive micro-flaking occurs on the black waves but seldom occurs on other patterns. A fine crystalline surface is evident on the black paint.
Information required: Reasons/hypotheses for salts migration and flaking – is the pigment significant? It appears generally blacker than many other areas. Is there more than one layer of paint?

34 I I
Bright white 'chalky' patches that appear on paint other than the resinous black.
Information required: Analysis to compare with chalk line efflorescence as above.

Brown/white patches, stepped chevron – 29 III ***Probably covered by IK #17**
It is unclear whether this is efflorescence or MBG. Also seen on Grey chevron.
Information required: I-D of material. Analysis of black/brown paint.

MBG
***Refer to Brian Ridout's report**

It would be useful to have a look at some areas to see whether it is possible to immediately rule out (or include) areas of doubt. It should be easier to formulate a strategy for MBG analysis after this initial sampling.
Common types:
'Tendrils' – 35 II h & 35 III x
'Brown spots' – 35 II h & 34 II h
'Blotchy' – 35 III e & 34 II r
Rare examples:
White spot disruption – 31 II y & z

White patches on areas of resinous black paint (metallic sheen) - General
These have occurred all over the ceiling so far and are directly related to the paint type beneath. It is unclear whether they are examples of efflorescence or MBG, or a component of the paint layer e.g. leeching wax. The resinous paint has a very metallic appearance and seems to date from the 1838 restoration.

GENERAL

Trefoil over medullary ray – 35 III u
sample across trefoil and medullary ray
sample across trefoil and background
To establish possible differences in the stratigraphy. Visual examination suggests that the relief effect first thought simply to be impasto paint is in many places too pronounced for the thickness of the paint. Furthermore, the impasto effect appears and fades along the boards with no evidence that some of the layer may have flaked. These observations - coupled with Howard's finding in 1997 that a similar pink layer was detected in a sample taken from an area further along the board, but where no trace of an underlying design is visible even in raking light - may suggest that a thin, less stable, original background paint layer (possibly size bound) may have been partially lost at an early date. The surface of the exposed areas of board deteriorated substantially as a result of environmental factors before being overpainted in the 1740s, while the protected timber under the original oil-based paint of the trefoil design was unaffected.

Ashlar boards, south and north sides – general
Information required: Has a wash been applied to 'dirty down' the surface? Is the visible white background a different date from the ceiling boards? If so, date?
May have been established in IK # 3-7

Surface staining, brown drips – 35 II h & 29 II
Information required: Are these likely to be deposits from the wood mobilised by water infiltration or chemical treatment residues?

Shiny stain- 35 IV h
This has penetrated from above in the same manner as the 'normal' glue, but is not water soluble and runs more freely, forming a stain. The darkness can be reduced with ammonium carbonate and IMS, but this may only be

reducing the surface dirt and not affecting the actual material. Is it the residue of an adhesive for an earlier hessian layer? Or some other treatment above?

Pigment alteration – 34 II b
The red paint layer has gone patchy 'grey' in places, possibly as a result of an intervention above.
Information required: Pigment analysis.

Surface sheen – 32 III a
A thin, streaky, shiny layer is visible on the red background with possible traces of MBG. This effect is usually associated only with repainted black. The appearance suggests a surface coating.
Information required: Analysis of coating.

Bloom, Dragon lozenge – 33 IV
The whole of the blue background is affected by this, suggesting a component of the blue pigment, perhaps affected by moisture, is the cause. The blue appears to be different from that of e.g. St Peter and may be the work of 1838, whereas the rest may be 1740 (?)
Information required: Analysis of pigment and layer structure.
*Sample 15 may not cover the information required.

Grooved boards on key pattern – general (NB 28 III e)
A sweep across both raised and grooved areas may indicate the original colour scheme. Areas will have to be carefully chosen to allow for the fact that the ceiling was 'washed down' prior to the 1740 restoration.
Information required: Layer structure and pigment analysis.
*Partially covered in # 12 & 13

*A similar sweep would be useful on the other grooved boards – Grey chevron and coloured bands.

NB
So far we have only found 'original' paint under nail heads on grooved boards. This suggests that only grooved boards were painted 'off site'.

Grey chevron – 33 II v & 33 III v
An example of 1838 repaint on a replacement board with no 1740 underpaint, to ascertain whether or not there is any difference in the pigments.

Micro-flaking – St Peter Lozenge: 31 II z
At present this represents the only example of micro-flaking other than that found on the black of the wave pattern. It would be useful to cross reference the information gathered, to assess the similarities in method and materials in order to try and establish the cause of the flaking.

Pink underpaint (?) 29 III d
The pink paint appears to be both under and over the cream ground.

Blue flake – 29 III d
A tiny flake of possible metal can be seen under a raised nail head. Could be related to the possible foil embellishment of the trefoils.

Black Paints aNd Coatings

General

When observing the panels from a distance it is worth noting the apparent use of two different blacks (or a black and a slate grey) in the painted design sequence. In general the black in the wave and extended chevron is an intense (velvety) black. The black in the stepped chevron, grey chevron and baseboards appear by contrast grey. The black used for the key motif has been both black and grey. The bun motif is generally black. The black dog tooth is generally grey, but it can be black.

Blacks in this category include some which may turn out to be coatings rather than paints.

The blacks present quite a complicated picture, which at the present time is confusing. Each black is briefly described. The blacks are listed in what is thought to be the order of their application. The first being the earliest, the last being the latest.

4.1 Thick brown black ***(numerous examples 31 III e, s)***

This is a thick brown black, which looks old and appears to be the earliest of the blacks. It is the only paint associated with delamination. It is found on the following boards: base boards, stepped chevron and ext. chevron. It would seem that a sample of what is defined here has been analysed by H. Howard in 1997, sample 17/2109. It would appear to be the earliest black layer 'large carbon black particles combined with yellow iron oxide and lead white 80 µm'

4.2 Deep matt black (a) ***(numerous examples 31 III d, u)***

This is found on wave pattern boards and associated with micro flaking. Visually this appears to be a single layer of paint without a ground. The paint layer is not thick, but it is saturated enough to produce a deep velvety layer of paint.

Further thoughts on this combined with the sample 19/2111 from the black of the wave pattern indicate that this black is a combination of two blacks. See section 5, 'two wave patterns'. The first black, which may be prone to micro flaking, would appear to be a 'dense black combined with lead white 65µm' applied over the first layer, presumably the ground 'lead white 45 µm'. Over this is a 'lead white 7 µm' followed by the later black 'shiny black pigment particles 15 µm'.

The 'shiny black pigment particles 15 µm may relate to the observations in section 8 'Paint damage' where possible crystalline faces are noted.

4.2 Deep matt black (b) ***(example 32 I u)***

This paint would seem to be identical to that in 4.3 (a) above. The only difference noticed so far is that it is not associated with micro flaking. It might be that this is found where the first black layer has remained well secured to the white ground, and where the white ground has remained well secured to the wood.

This paint could be the same as that found on the ashlar boards.

4.3 Thick resinous coating ***(numerous examples 31 III l and 29 IV s – where investigations were conducted)***

Visually this coating appears to be a thick layer associated with the white patchy MBG. It is possible to remove the white patches very easily with acetone; in fact the swab only has to touch white patchy areas for it to be removed. The material removed by the action of the swab is yellow. Analysis by Brian Ridout states that the white patchy MBG is a crystalline deposit associated with the paint and not MBG. It is found on baseboards and grey chevron. It is possible that the sample 25/2117 Howard (1997) from 31 III v shows the white crystalline deposit in cross section; although Howard makes no mention of crystalline characteristics, but says 'pale white layer on the surface 10 µm [consolidant as yet unidentified]. Inner portion of this stains positive for lead, as does ground'. This would appear to back up Ridout's comment that the deposit is associated with the paint. This hypothesis assumes that Howard's sample is of the white crystalline deposit.

Continued application of acetone draws or dissolves brown deposits. This could be a thick paint layer as indicated in Howard's samples (1997) 17/2109 'brown and yellow oxide particles combined with brilliant yellow and black 150 µm' and 25/2117 'dense dark layer with black, brown and yellow inclusions 750 µm'.

4.4 Thin black glaze ***(numerous examples 31 III o, p and 32 III h, i)***

There appears to be a thin shiny black glaze on some original boards with wave and extended chevron pattern. The application of this glaze is not uniform with areas being missed. The coating is soluble in acetone, behaving like a glaze. Where the glaze has not been applied to the underlying black surface, this surface is relatively matt. Another surface quality is encountered in these areas, it has a bloom/milky quality to it and would appear to be an altered version of the glaze. This bloom/milky quality tends to be found on the side of the board next to the board which overlaps it.

4.5 Black/purple ***(examples 30 IV d [dog tooth] and 31 IV m [dog tooth])***

This is only found on replacement boards. On the 1830's boards it would appear to be the only black, on the 1740's boards it can be found over an earlier black. It would therefore appear to be an 1830's black. Small areas of impasto in the paint can be shiny, i.e. the edges of brush marks.

The dating used here follows the suppositions made in section 10. These are suppositions only.

4.6 Black/black ***(examples 30 IV d [bun pattern] and 31 IV m [bun pattern])***

Like the previous category, 4.5, this is only found on replacement boards. It could be related to observations in sections 4.2 (a) & (b). It is found over underpaint which is thought to date from the 1740's. There are irregularities of sheen on the paint surface (matt, shiny, bloom/milky) again similar to section 4.2.

The dating used here follows the suppositions made in section 10. These are suppositions only.

4.7 Velvety/black ***(example 32 III c)***

This appears thicker than the black/black (4.6), but otherwise could be the same as 4.6. Only found on replacement boards. Paint edges can have a shiny edge.

4.8 Black coating, resinous medium where it is in impasto ***(example 34 III e)***

To date this has only been found on replacement boards dating from the last restoration. It overlies the black/purple. As mentioned in the heading the coating looks resinous where it has been applied in impasto, elsewhere it is matt.

4.9 The black on the 1880's boards ***(example 35 IV e, f, g)***

The black found on the 1880's boards is more of a dark slate grey. It seems to only be found on these boards.

The Perry Lithgow Partnership July 1999

9 Providence Row,
Durham,
DH1 1RS
Tel. 0191 386 5523

6.10.99

Dear Mr. Harrison,

May I now send you written confirmation of the fibre identifications which I have previously reported verbally?

The material which you refer to as hessian is made from jute, a species of Corchorus. The canvas strip attached to it is made from cotton, a species of Gossypium.

I am surprised that you found no deterioration of the hessian. Is it possible that the quality of the fibre varies within the fabric? The sample which you sent to me is severely degraded. Jute is a lignified baste fibre and is notorious for its deterioration.

Unfortunately, I am unable to suggest a date for the manufacture of these materials.

I enclose an invoice for my consultancy fee.

I hope you will accept my report in this hand written form. Although I am an Honorary Research Fellow at Durham University, fibre identifications are entirely my responsibility.

Yours sincerely,

Dorothy Catling.

DR. D. M. CATLING.

From: Lieutenant Colonel (Retd) A WILSON MBE

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Hugh Harrison
Ringcombe Farm
West Anstey
SOUTH MOLTON
Devon EX36 3NZ

Your reference:

Our reference: Q/Shot

Date: 29 June 1999

Dear Hugh.

Many thanks for you letter dated 22 Jun 99 reference 'shot'. Needless to say the contents excited many of the 'natives' here!

Being a military weapons establishment the 'shotgun' does not feature highly as it was/is used sparingly for service use. That stated we still have a historical interest.

We know that in 1524 a certain Benvenuto Cellini mentions the use of 'hail shot' which was produced by cutting sheets of lead into cubes! There is also reference to the making of shot (dropping molten lead from a certain height - shot towers) in the last quarter of the 17th Cent. So shot has been around for some time.

Shotgun performance varies so much from shot to shot, load to load and gun to gun, and shot size varies between makers. From your samples we can make a fairly accurate guess as to the shot size, however, the information you gave regarding spread is insufficient to determine possible range of firing and type of 'weapon'. Needless to say - all of the above cannot produce the information you seek - the date of the shot.

I do not know if lead can be 'carbon dated'? I doubt it, however, even if it could be done it would be a costly exercise!

You asked when the first 'shotgun cartridge' appeared - in the early stages of the 19th Cent.

Sorry I could not be more helpful.

Yours aye
Tug.