

PRELIMINARY INVESTIGATION OF DAMP, DECAY AND RELATED BUILDING DEFECTS SUBSEQUENT TO PURCHASE OF THE MILL, CLIMPING STREET, CLIMPING, LITTLEHAMPTON BN17 5RG FOR 31 MAY–2 JUNE 2017, JOB NO. 147.12A



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1 INTRODUCTION

1.1 AUTHORITY AND REFERENCE

Hutton+Rostron Environmental Investigations Limited carried out a preliminary Rothound timber decay and damp survey of The Mill, Climping Street, Climping, Littlehampton, BN17 5RG on 31 May-2 June 2017 in accordance with instructions received from Mr Gary Love by email dated 2 May 2017 (12:51). Reference was made to drawings supplied by the client, for the identification of structures. For the purpose of orientation in this report, the front of the building was taken as facing south

1.2 AIM

The aim of this investigation was to determine the probable extent of damp, decay and related building defects prior to refurbishment, so that advice can be given suitable for planning and QS purposes on cost effective conservation and remedial measures to minimise the risk of damp and decay related problems after refurbishment for domestic occupancy, and so as to allow the sustainable conservation of historically important materials

1.3 LIMITATIONS

This survey was confined to the accessible structures. Concealed timbers and cavities have been investigated where necessary by the use of high-powered fibre optics or Rothounds. The condition of concealed timbers may be deduced from the reactions of the Rothounds or from the general condition and moisture content of the adjacent structure. Only demolition or exposure work can enable the condition of timber to be determined with certainty, and this destroys what it is intended to preserve. Specialist investigative techniques are therefore employed as aids to the surveyor. No such technique can be 100 per cent reliable, but their use allows deductions to be made about the most probable condition of materials at the time of examination. Structures were not examined in detail except as described in this report, and no liability can be accepted for defects that may exist in other parts of the building. We have not inspected woodwork or other parts of the structure which are covered, unexposed or inaccessible and we are therefore unable to report that any such part of the property is free from defect or in the event that such part of the property is not free from defect it will not contaminate and/or affect any other part of the property. Any design work carried out in conjunction with this report has taken account of available pre-construction or construction phase information to assist in the management of health and safety risks. The sample remedial details and other recommendations in this report are included to advise and inform the design team appointed by the client. The contents of this report do not imply the adoption of the role of Principal Designer by H+R for the purposes of the Construction Design and Management (CDM) Regulations 2015. No formal investigation of moisture distribution was made

2 EXECUTIVE SUMMARY

2.1 OBSERVATIONS

- 1 Dry rot: The H+R Rothound dry rot search dog gave positive indications of active dry rot (*Serpula lacrymans*) infection at a number of locations, as shown on Plans at Appendix G. Timbers built in contact with masonry in these areas were very vulnerable to decay, before, during and after any future refurbishment, especially if further water penetration occurs
- 2 Wet rot: There was active wet rot decay affecting timbers of the ground floors, and affecting external window and door frame timbers, which had been painted with layers of impermeable paint. There was also evidence of old wet rot decay beneath roof valleys and associated with defective roof drainage
- 3 Wood boring beetle: There was evidence of active decay by wood boring weevil to ground floor timbers partially decayed by wet rot, as described at 2 above. There was also some evidence of infestation and decay to the sapwood band of timbers elsewhere in the structure in the past. However, no other evidence of active or structurally significant decay by wood boring beetle was found on preliminary inspection
- 4 Mill frames: The mill structure to the south-west reportedly built in 1799 had been 'razeed' or truncated on a previous refurbishment, presumably due to concerns about its structural stability at that time. The main mill spars were of softwood and some were found to have been structurally decayed at their base. Joists, frames and beams included softwood and oak timbers, possibly salvaged from previous structures. These could not be inspected in detail at the time of survey. However, they had been locally decayed, especially at their joints. This may be structurally significant
- 5 Lintels: Lintels over window openings in the original building would have generally been of timber. These were not inspected in detail at the time of survey. However, some of the lintels were found to have been decayed or partially decayed, and some appeared to be no longer structurally adequate. Lintels over window and door openings in the north wing appeared to be of masonry or steel with only limited timber elements. This made them relatively resistant to decay
- 6 Primary beam bearings: First floor structures were supported on primary beams in the mill and at the south end of the main building. The bearing ends of these beams were not inspected in detail at the time of survey. However, those in the mill had been subject to previous remedial treatment and repair, and bearing ends of at least 1 no. primary beam in the main house had been structurally decayed
- 7 Windows: The majority of existing windows appear to have been replaced with timber sash windows, presumably in the late 19th Century or early 20th Century. These had been painted with layers of impermeable paint, which had allowed water penetration but restricted drying, providing conditions for wet rot decay; especially at the base of external frames and sills. Windows had generally been painted shut, preventing 'background ventilation' on previous occupancy

- 8 Roof timbers: Roof timbers could not be inspected in detail at the time of survey due to restricted time and access. However, these appeared to have been subject to recent remedial treatment and repair. However, timbers beneath the central valley and in other areas subject to water penetration in the past had remained vulnerable to decay. The structural adequacy of existing timbers to carry the loads to be expected during and after refurbishment could not be determined at the time of survey. Flat roof structures were not accessible for inspection
- 9 Floor structures: First floor timbers were not accessible for detailed inspection at the time of survey. However, bearing ends of joists and underlying plates built in contact with structures subject to chronic water penetration from defective roof drainage were very vulnerable to decay, before, during and after refurbishment; especially in areas of dry rot (*Serpula lacrymans*) infection as described at 1 above. Timber ground floor structures had generally been decayed or partially decayed by wet rot, and were very vulnerable to further decay, before, during and after refurbishment
- 10 Roof surfaces: Existing roof surfaces appeared to have been extensively patch repaired and re-laid or replaced on previous refurbishment. However, the existing pitched and flat roof surfaces appeared to have a very limited service life
- 11 Roof drainage: Existing provision for roof drainage was in very poor condition and had been relatively inaccessible for inspection and maintenance. Many sections of the roof drainage were very poorly detailed and vulnerable to blockage and overcharging. This had allowed chronic water penetration to structures beneath in the past, providing conditions for damp and decay
- 12 Chimneys: Chimneys were not inspected in detail at the time of survey. However, chimney pots were generally open, and haunching, pointing and flashing appeared to be coming to the end of their useful lives. This was allowing water penetration to structures beneath, providing conditions for damp and decay
- 13 Masonry facades: The facades were generally of a mixture of knapped flint or beach cobble and brickwork, as shown on Photographs at Appendix F. Original lime mortar had been heavily eroded and patch repaired in the past using cementitious mortars. These had allowed water penetration but restricted drying, providing conditions for further erosion, damp and decay. This may become structurally significant, and there was evidence of settlement cracks in many areas; especially to the south side of the Mill, the main house, and to the outhouses to the north-east. Samples of original mortar were taken and submitted to the reference laboratory at Sandbergs for analysis
- 14 Clapboard facades: The facades of the mill and the first floor extension at the north-west re-entrant corner had been clad with clapboarding. This was non-original and dated from previous refurbishments. Generally, clapboarding had been painted with layers of impermeable paint. This would allow water penetration but restrict drying, providing conditions for wet rot decay; especially adjacent to defective flashings to the main structure. There was also a section of timber shingles on the façade of the south first floor bay. These appeared to be coming to the end of their useful life
- 15 Insulation and ventilation of roof structures: Inadequate provision had been made for insulation or ventilation of roof structures on previous refurbishment. This had prevented drying in areas subject to water penetration, and provided conditions for intermittent interstitial condensation on future occupancy
- 16 Building hygiene: There appeared to be materials containing asbestos mineral fibres within the building. These may represent a potential health hazard preventing inspection and refurbishment. Roof voids and insulation were also heavily contaminated with dust and debris. These were likely to contain residues from previous chemical remedial treatments, lead oxides, and other potentially irritant or hazardous

materials. These represent a potential irritant or health hazard to those working in the roof structures, or occupying the building below during and after refurbishment

- 17 Ventilation to sub-floor voids: Inadequate provision had been made for through and cross ventilation to the suspended floor voids in the main building on previous refurbishment. This had provided conditions for damp and decay as described at 9 above
- 18 Internal cladding: Ceilings and internal wall claddings had generally been replaced on previous refurbishments with plasterboards and other non-original materials. These had been subject to damage due to chronic water penetration and to interstitial mould growth, as shown on Photographs at Appendix F. Existing ceilings and claddings were very vulnerable to further damage during and after refurbishment, and prevented access to original fabric for conservation and repair
- 19 Damp-proofing: It was not possible to inspect damp-proof courses in detail at the time of survey. However, the main building and north wing appeared to have an original slate physical damp-proof course. This had generally been bridged by installation of concrete slab floors on previous refurbishment, and by ground levels having risen significantly since original construction. This was allowing chronic problems with moisture and salt penetration into the base of walls and foundations throughout the buildings, providing conditions for damp and decay
- 20 Solid ground floor structures: It was not possible to inspect solid ground floor structures in detail at the time of survey. However, these generally appeared to have been replaced with concrete screeds or slabs on previous refurbishment, with no special provision for insulation or damp-proofing. This was allowing moisture and salt penetration, providing conditions for damp and decay; especially at construction joints and at the floor/wall junctions
- 21 Ground and surface drainage: Although the ground was naturally well drained; ground levels had generally risen significantly since original construction and existing provision for ground and surface drainage was allowing water to drain into the base of walls and foundations. This was providing conditions for damp and decay, before, during and after refurbishment

2.2 RECOMMENDATIONS

- 1 Dry rot: No chemical remedial timber treatments or wall irrigations are required. However, all timber elements built in contact with structures subject to chronic water penetration in the past, should be fully exposed, inspected in detail by deep drilling and probing, so as to determine their decay state and deep moisture content. Allowance should be made for repairing and re-supporting timber elements separated from damp or potentially damp masonry with a damp-proof material and/or through ventilated air gap, using a detail specified by a Structural Engineer and approved by H+R
- 2 Wet rot: See recommendations at 1 above
- 3 Wood boring beetle: No insecticidal or chemical remedial timber treatments are required. On refurbishment, adequate provision should be made for heating and ventilation, so as to allow long term drying and minimise the risk of condensation. Consideration should be given to installing electrical UV flying insect traps in all roof voids; so as to control emerging wood boring beetle, and so as to control wasps, cluster flies and other nuisance flying insects on future occupancy
- 4 Mill frames: If it is intended to reconstruct the mill to its original profile; allowance should be made for extensive partnering with steel elements, especially to the main spars and

to joints between frame elements, as directed by the Structural Engineer. Allowance should also be made for re-cladding of the residual original structure, both internally and externally; so as to allow access for inspection and repair, and so as to match the original and allow sustainable occupancy

- 5 Lintels: All lintels over window and door openings to be retained on refurbishment should be inspected in detail by deep drilling and probing, so as to determine their structure, decay state and deep moisture content. Allowance should be made for replacing lintels over window and door openings in areas subject to chronic water penetration, as shown on Plans at Appendix G. Consideration should be given to providing temporary support to window and door openings with structurally decayed lintels, as directed by the Structural Engineer
- 6 Primary beam bearings: The bearing ends of all primary beams should be inspected in detail when full access is available by deep drilling and probing, so as to determine their decay state and deep moisture content at that time. Allowance should be made for repair and re-supporting the bearing ends of all primary beams in areas subject to chronic water penetration, as directed by the Structural Engineer. Consideration should be given to providing temporary support to the structurally decayed beam bearing at the south end of the main building
- 7 Windows: All existing windows to be retained on refurbishment should be stripped of impermeable paint finishes, inspected in detail; and repaired and reinstated as necessary, using highly breathable microporous paints, and ensuring timber elements are re-supported isolated from damp masonry with a damp-proof material. Consideration should be given to re-detailing, including provision for double or secondary glazing, shutters, 'trickle ventilation' and window catches to allow them to be securely locked in a partially open position, so as to improve 'U-values' and facilitate 'background ventilation' on future occupancy. H+R can advise further when required
- 8 Roof timbers: All roof timbers should be inspected in detail by deep drilling and probing when full access is available, so as to determine their decay state and deep moisture content at that time. Allowance should be made for repair and re-support of all timbers in areas subject to chronic water penetration; as directed by the Structural Engineer, using a detail approved by H+R. In particular, allowance should be made for replacing existing flat roof structures with new throughout
- 9 Floor structures: Allowance should be made for lifting and replacing all ground floor timbers using new or salvaged timbers. If new suspended floors are to be created, adequate provision should be made for through and cross ventilation and for insulation, so as to meet the requirements of current Building Regulations; and timber elements should be re-supported isolated from damp or potentially damp structures with a damp-proof material. The structural adequacy of existing floor timbers to carry the loads to be expected during and after refurbishment should be determined by the Structural Engineer. H+R can advise further after visual in-situ strength grading, and after detailed inspection as described at 1 above. Allowance should be made for re-supporting bearing ends of all joists and underlying plates in areas subject to chronic water penetration, as shown on Plans at Appendix G
- 10 Roof surfaces: All roof surfaces should be inspected in detail when full access is available, so as to determine their condition and probable service life. Allowance should be made for re-laying all pitched and flat roof surfaces with new to match the original; and for including provision for ventilation as 'insulated and through ventilated cold roof structures', fully in accordance with requirements of current Building Regulations. Consideration should be given to installing solar heating and/or electrical generating systems, in conjunction with re-roofing works

- 11 Roof drainage: All existing valley parapet and eaves gutters should be re-lined and replaced with new high capacity rainwater goods; including provision for overflow and provision for access, so as to facilitate inspection and maintenance on future occupancy, as described in General Recommendations at section 5 below. Consideration should be given to installing electronic radio telemetric gutter water level monitoring alarm systems as an aid to facilities managers
- 12 Chimneys: All chimneys and chimneystacks should be inspected in detail when full access is available. Allowance should be made for opening and clearing all active and redundant flues; capping redundant flues so as to minimise water penetration but allow continued through ventilation; and for replacing haunching, pointing and flashing using appropriate highly breathable salt resistant remedial lime mortars, lead flashings and soakers. H+R can advise further when required
- 13 Masonry facades: The significance of the settlement cracks in the masonry should be determined by a Structural Engineer. Allowance should be made for repair, tying-in and underpinning as directed by the Structural Engineer. Generally, masonry should be inspected in detail and allowance should be made for re-pointing and repairing and repointing throughout, using appropriate salt resistant and highly breathable remedial lime mortars and flashings
- 14 Clapboard façades: Allowance should be made for replacing all existing clapboarding and shingles with new to match the original. Highly breathable microporous paint systems should be used, and provision should be made for insulation and ventilation behind. Allowance should also be made for replacing all flashings to adjoining structures with new lead flashings and soakers, laid fully in accordance with current LSA Guidelines. H+R can advise further when required
- 15 Insulation and ventilation of roof structures: On refurbishment, existing insulation should be removed, and new provision made for insulation and ventilation throughout to all roof structures as 'insulated and through ventilated cold roofs'; fully in accordance with the requirements of current Building Regulations. H+R can advise further when required
- 16 Building hygiene: The building should be inspected for asbestos containing materials, fully in accordance with the current Control of Asbestos Regulations. Consideration should be given to removing all contaminated dust, debris and insulation materials from roof structures and other building voids at an early stage during enabling or refurbishment works. Those undertaking this task should be provided with appropriate respiratory protection and protective clothing, and all practical measures should be taken to prevent potentially contaminated dust entering occupied air spaces during and after refurbishment
- 17 Ventilation to sub-floor voids: If suspended timber floors are to be retained at ground floor level on refurbishment, these should be re-laid, including provision for through and cross ventilation, equivalent to at least 1,500mm² of vented area per metre of external, wall and 500mm² of vented area per metre squared of floor surface; fully in accordance with requirements of current Building Regulations. H+R can advise further on detailing when required
- 18 Internal cladding: All existing ceilings and claddings should be inspected in detail to identify any original and historically important materials to be conserved on refurbishment. Consideration should be given to removing all non-original ceilings and wall claddings at an early stage during enabling and refurbishment works; so as to allow access to structures behind for inspection, conservation and drying as necessary. In particular, consideration should be given to removing all ceilings at first floor level, so as to allow inspection and decontamination of roof structures as described at 16 above.

On refurbishment, allowance should be made for re-cladding all existing walls with insulated and through ventilated dry linings. This may be done using panelling, lath and plaster, or other historically acceptable finishes to match the original where required

- 19 Damp-proofing: No injection of 'chemical damp-proof course materials' or application of 'proprietary tanking systems' is required. On refurbishment, consideration should be given to forming a 'vertical damp-proof course', formed of a strip of studded plastic damp-proof membrane across the floor/wall junction extending to, say, 1m above external landscaped ground levels behind insulated and ventilated dry lining details as described at 18 above. H+R can advise further on detailing when required
- 20 Solid ground floor structures: Consideration should be given to lifting all existing floor slabs and screeds, and re-laying with new, including provision for insulation and ventilation, fully in accordance with the requirements of current Building Regulations. Consideration should be given to installing underfloor heating systems during these works, so as to facilitate the long-term drying and conservation of original fabric
- 21 Ground and surface drainage: Existing provision for ground and surface drainage should be inspected using CCTV and cleared as necessary. Consideration should be given to reducing ground levels around the site at an early stage during enabling works to, say, 300mm below internal floor levels, and/or to original ground levels. Consideration should be given to making provision for temporary ground and surface drainage, so as to drain water clear of the base of the walls and foundations during refurbishment works. On refurbishment, provision should be made for new ground and surface drainage throughout; especially at the base of rainwater downpipes and at thresholds to door openings. This should be inspected and 'certified as clear' by the project managers at completion of refurbishment works

3 OBSERVATIONS

Some structural timber decay had occurred in the past and there were some areas of active timber decay infection. There were a number of building defects that allowed moisture build-up in the structure and provided the conditions for timber decay organisms to grow (see Appendix A)

3.1 EXTERIORS

3.1.1 South elevations

- 1 The mill tower: The mill tower consisted of an original softwood timber frame structure clad with softwood clapboarding on a previous refurbishment. This had been painted with layers of impermeable paint, which had allowed water penetration but restricted drying, providing conditions for localised wet rot decay, especially at the base of the timber frame structure and where flashed to adjoining structures to the east
- 2 Roof drainage: Roofs drained via relatively narrow eaves gutters and rainwater downpipes. The latter were severely 'dog-legged' and very vulnerable to blockage and overcharging. This had allowed chronic water penetration to structures beneath in the past, providing conditions for plant growth, damp and decay, especially at the re-entrant corner with the mill and the main building to the east
- 3 First floor bay: The bay acting as a link structure between the original mill and the main mill house to the east had been clad with what appeared to be cedar shingles on original construction or previous refurbishment, onto a timber frame. These appear to be coming to the end of their useful lives and timber structures were subject to chronic water penetration due to defective flashings to adjoining structures and defective roof drainage as described above
- 4 Windows: The Mill, bay and main building had softwood sash and casement windows painted with layers of impermeable paint. This was allowing water penetration but restricting drying, providing conditions for localised wet rot decay, especially to the base of external frames and sills. Windows were very vulnerable to water penetration due to wind driven rain on the exposed south and west elevations and windows generally appeared to have been painted shut, limiting background ventilation on previous occupancy. This would provide conditions for condensation, mould growth, damp and decay
- 5 Gable end to main house: The gable end to the main house included 'bargeboards' and clapboarding and was supported onto corbelled out plates by the side of the bay. Timber elements were not accessible for inspection at the time of survey. However, these had been painted with layers of impermeable paint, which had allowed water penetration and restricted drying. This would have provided conditions for localised wet rot decay, especially on the exposed south and west elevations
- 6 Façade to main house: The façade of the main house consisted of knapped flint and/or beach cobble and brickwork originally laid with a lime mortar. This had been heavily eroded locally and patch repaired using cementitious mortars. These had allowed

water penetration but restricted drying, resulting in further erosion and providing conditions for damp and decay. There were also settlement cracks visible in the brickwork above and below window openings at ground floor level. These may be structurally significant

- 7 Masonry base to mill tower: The mill tower described at 1 above was supported on a masonry base at ground floor level. This consisted of knapped flint and/or beach cobbles and brickwork up to 1m thick with brick corners and reveals, laid with what appeared to be a lime mortar containing relatively high levels of pozzolanic materials, including clinker ash. However, this had been heavily eroded and subject to chronic water penetration from defective flashing at first floor level, defective roof drainage and wind driven rain. Original pointing mortar had been extensively patched, using cementitious materials and masonry appeared to have cracked and settled significantly, especially to the south-west. This may be structurally significant, as it was possible that the foundations may also be being 'washed out'. A sample of the original lime mortar was taken and submitted to the reference laboratory at Sandbergs for analysis
- 8 Vents at base of wall: There were a number of vents at the base of the wall of the main house, presumably intended to provide through and cross ventilation to original suspended floor structure. These generally appeared to have been blocked or partially blocked but were likely to allow water penetration to the structure, especially during periods of wind driven rain
- 9 Damp-proof course: Damp-proofing at the base of the walls could not be inspected in detail at the time of survey. However, although there appeared to be an original slate damp-proof course at the base of the walls of the main building; this appeared to have been extensively bridged by ground levels having risen since original construction and by the laying of concrete screeds or slabs to the interior
- 10 Ground levels: Ground levels were generally at or above internal floor levels with ground levels significantly above internal floor levels to the west. This was 'bridging' original provision for damp-proofing, allowing ground and surface drainage to drain water into the base of the walls and foundations
- 11 Ground and surface drainage: Ground and surface drainage was not inspected in detail at the time of survey. However, although the ground was relatively well drained, ground and surface drainage was tending to drain water into the base of the walls and foundations from the south and west. There was also evidence of chronic water penetration into the base of the walls and foundations from drainage gullies at the base of rainwater downpipes
- 12 Bay link structure: The structure supporting the central first floor bay could not be inspected in detail at the time of survey. However, preliminary inspection using high-powered fibre optic borescope revealed what appeared to be timber beams or plates supporting the bay, bearing into the masonry of the adjoining structures. No structurally significant decay was detected on preliminary drilling of bearing ends. However, deep moisture content of timber bearing to the east was over 20 per cent, which was damp enough for decay to occur and timbers built into dry rot (*Serpula lacrymans*) infected masonry. The base of the timber posts supporting the bay had been decayed by wet rot for over 50 per cent of their section and may no longer be structurally adequate
- 13 'Mill stone paving': The base of the timber posts supporting the bay described above, appeared to be supported on original composite mill stones. These had been severely damaged and heavily eroded but may be an historically important feature

3.1.2 East elevations

- 1 Roof drainage: Roofs drained to a relatively narrow and severely damaged eaves gutter and down relatively narrow rainwater downpipes. These were at the end of their useful lives and allowed chronic water penetration to structures beneath, providing conditions for damp and decay. Generally, roof drainage was very vulnerable to blockage and overcharging, especially given wind driven rain
- 2 Facades: The façade of the main building consisted of knapped flints and/or beach cobbles and brickwork laid with what appeared to be relatively strong high pozzolanic lime mortar, including clinker ash. This had been heavily eroded locally, especially towards ground level and had been extensively patched with what appeared to be strong cementitious mortars. These would allow water penetration but restrict drying, providing conditions for further erosion, damp and decay. Erosion to the mortar at ground floor and other areas subject to chronic water penetration on the north elevation at the re-entrant corner with the north wing may become structurally significant. A sample was taken of representative original lime mortar and submitted to the reference laboratory at Sandbergs for analysis
- 3 Windows: The main building and wings had softwood sash and casement windows painted with layers of impermeable paint. This was allowing water penetration but restricting drying, providing conditions for localised wet rot decay, especially to the base of external frames and sills. Windows were very vulnerable to water penetration due to wind driven rain on the exposed south and west elevations and windows generally appeared to have been painted shut, limiting background ventilation on previous occupancy. This would provide conditions for condensation, mould growth, damp and decay
- 4 Damp-proof course: Damp-proofing at the base of the walls could not be inspected in detail at the time of survey. However, although there appeared to be an original slate damp-proof course at the base of the walls; this appeared to have been extensively bridged by ground levels having risen since original construction and by the laying of concrete screeds or slabs to the interior
- 5 Ground levels: Ground levels were generally at or above internal floor levels with ground levels significantly above internal floor levels to the north. This was 'bridging' original provision for damp-proofing, allowing ground and surface drainage to drain water into the base of the walls and foundations
- 6 Ground and surface drainage: Ground and surface drainage was not inspected in detail at the time of survey. However, although the ground was relatively well drained, ground and surface drainage was tending to drain water into the base of the walls and foundations from the north and east. There was also evidence of chronic water penetration into the base of the walls and foundations from drainage gullies at the base of rainwater downpipes
- 7 East elevation of north wing: The east elevation of the north wing consisted of fair faced brickwork. This appeared to be in relatively good condition and had been subject to localised water penetration and erosion and ? patch repairs using cementitious mortars
- 8 Ground floor extension: There was a ground floor extension towards the north end of the east elevation, consisted of a boiler room, pantry and larder or smoke room. The brickwork walls of these structures was in poor condition and appeared to be failing especially in the game larder or smoke house to the east and ground and surface drainage allowing chronic water penetration to the base of the walls and foundations, especially to the north, where no special provision appeared to have been made for damp-proofing on original construction or previous refurbishment

- 9 Boundary wall to east: There was a decorative boundary wall to the east, consisting of what appeared to be beach cobbles and brickwork laid with lime mortar. This had been heavily eroded and masonry of the walls and pillars may be locally structurally unstable

3.1.3 North elevation

- 1 Roof drainage: Roofs drained to a relatively narrow and severely damaged eaves gutter and down relatively narrow rainwater downpipes. These were at the end of their useful lives and allowed chronic water penetration to structures beneath, providing conditions for damp and decay. Generally, roof drainage was very vulnerable to blockage and overcharging, especially given wind driven rain
- 2 Façade: The north elevation of the north wing consisted of fair-faced brickwork. This appeared to be in relatively good condition and had been subject to localised water penetration and erosion and patch repairs using cementitious mortars
- 3 Windows: The building had softwood sash and casement windows painted with layers of impermeable paint. This was allowing water penetration but restricting drying, providing conditions for localised wet rot decay, especially to the base of external frames and sills. Windows were very vulnerable to water penetration due to wind driven rain on the exposed south and west elevations and windows generally appeared to have been painted shut, limiting background ventilation on previous occupancy. This would provide conditions for condensation, mould growth, damp and decay
- 4 Damp-proof course: Damp-proofing at the base of the walls could not be inspected in detail at the time of survey. However, although there appeared to be an original slate damp-proof course at the base of the walls; this appeared to have been extensively bridged by ground levels having risen since original construction and by the laying of concrete screeds or slabs to the interior
- 5 Ground and surface drainage: Ground and surface drainage was not inspected in detail at the time of survey. However, although ground was relatively well drained, ground and surface drainage was tending to drain water into the base of the walls and foundations from the north. There was also evidence of chronic water penetration into the base of the walls and foundations from drainage gullies at the base of rainwater downpipes
- 6 Ground levels: Ground levels were generally at or above internal floor levels. This was 'bridging' original provision for damp-proofing, allowing ground and surface drainage to drain water into the base of the walls and foundations

3.1.4 West elevations

- 1 Roof drainage: The complex of pitched roof surfaces on the west elevations generally drained to relatively narrow eaves gutters and rainwater downpipes, with some sections of valley gutter between ground floor extensions and the main façade. Generally, existing eaves gutters were in poor condition, blocked and overcharging water onto structures beneath and rainwater downpipes were generally severely dog-legged and leaking. This had allowed chronic water penetration to structures beneath, providing conditions for damp and decay
- 2 The mill tower to south: The mill tower consisted of an original softwood timber frame structure clad with softwood clapboarding on a previous refurbishment. This had been painted with layers of impermeable paint, which had allowed water penetration but restricted drying, providing conditions for localised wet rot decay, especially at the base of the timber frame structure and where flashed to adjoining structures to the east

- 3 Façade on main building: The facades on the main building appeared to consist of a mixture of beach cobble or knapped flint and brickwork, laid with original lime mortars. However, these had been extensively patch repaired using brickwork and what appeared to be cementitious mortars. The facades of ground floor extensions and of the north wing were generally of fair faced brickwork and again this had been extensively eroded where subject to chronic water penetration and patch repaired using what appeared to be cementitious mortars. This would allow water penetration but restrict drying
- 4 Windows: The main buildings generally had softwood sash and casement windows painted with layers of impermeable paint. This was allowing water penetration but restricting drying, providing conditions for localised wet rot decay, especially to the base of external frames and sills. Windows were very vulnerable to water penetration due to wind driven rain on the exposed south and west elevations and windows generally appeared to have been painted shut, limiting background ventilation on previous occupancy. This would provide conditions for condensation, mould growth, damp and decay
- 5 Clapboarding of façade of link at first floor level at the south end of the elevation: The link at the re-entrant corner between the main building and the mill tower at the south end of the elevation had been clad with clapboarding on original construction or previous refurbishments. This was not accessible for detailed inspection at the time of survey. However, it appeared to have been subject to chronic water penetration, providing conditions for localised wet rot decay, especially at the flashings to the main building to the east
- 6 Masonry base to mill tower: The mill tower described at 2 above was supported on a masonry base at ground floor level. This consisted of knapped flint and/or beach cobbles and brickwork up to 1m thick with brick corners and reveals, laid with what appeared to be a lime mortar containing relatively high levels of pozzolanic materials, including clinker ash. However, this had been heavily eroded and subject to chronic water penetration from defective flashing at first floor level, defective roof drainage and wind driven rain. Original pointing mortar had been extensively patched, using cementitious materials and masonry appeared to have eroded significantly, especially to the south-west. This may be structurally significant. A sample was taken from representative original lime mortar and submitted to the reference laboratory at Sandbergs for analysis
- 7 Damp-proof course: Damp-proofing at the base of the walls could not be inspected in detail at the time of survey. However, although there appeared to be an original slate damp-proof course at the base of the walls of the main building and north wing; this appeared to have been extensively bridged by ground levels having risen since original construction and by the laying of concrete screeds or slabs to the interior
- 8 Ground levels: Ground levels were generally at or above internal floor levels with ground levels significantly above internal floor levels locally. This was 'bridging' original provision for damp-proofing, allowing ground and surface drainage to drain water into the base of the walls and foundations
- 9 Ground and surface drainage: Ground and surface drainage was not inspected in detail at the time of survey. However, although ground was relatively well drained, ground and surface drainage was tending to drain water into the base of the walls and foundations from the north and west. There is also evidence of chronic water penetration into the base of the walls and foundations from drainage gullies at the base of rainwater downpipes

- 10 Garden wall to west: There was a beach cobble or knap flint garden wall abutting the structure to the west. Pointing and flashing to the garden wall appeared to be in poor condition and was allowing water penetration into the main structure. Erosion to pointing and damage to masonry may be structurally significant, and previous patch repairs using cementitious mortars are likely to result in accelerated erosion and spalling

3.1.5 Roofs

- 1 Chimney pots and flues: Chimney pots and flues were not inspected in detail at the time of survey. However, the majority appeared to be open. This would allow water penetration and would not provide through ventilation and drying unless flues and fireplaces beneath were also vented, which did not appear to be the case
- 2 Chimneystacks: Chimneystacks were not inspected in detail at the time of survey. However, haunching, pointing and flashing appeared to be heavily eroded and coming to the end of its useful life. Generally, chimneys were very vulnerable to water penetration from wind driven rain, especially from the south and west and a number of chimneys had been heavily eroded. This had allowed chronic water penetration to structures beneath in the past, providing conditions for damp and decay. There appeared to be a redundant chimney capped at the north end of the south pitched roof with no provision for ventilation
- 3 Mill roof: The original mill tower had been 'razeed' or truncated and finished with a flat roof with bitumen felt. This appeared to have a limited service life and no provision appeared to have been made for insulation or ventilation
- 4 Flat roof over link structure or bay: The link structure between the mill and the main building, forming the south bay had a flat roof structure. This had been relatively recently repaired with bituminous felt but had a very limited service life
- 5 Pitched roof over north side of main building: The pitched roof over the north side of the main building had been finished with slates to the north and tiles to the south. These appear to have been relatively recently re-laid, but appeared to have a very limited service life and flashings to adjoining structures appeared to be in poor condition
- 6 Pitched roof over south side of main building: The pitched roof over the south side of the main building appeared to have been relatively recently repaired or re-laid using salvaged tiles. However, these appeared to have a limited service life
- 7 Flat roof over south bay of main building: The flat roof over the south bay of the main building had been recently patch repaired using bituminous felt and 'flashband'. This had a very limited service life; and was likely to have allowed chronic water penetration to structures beneath in the past, providing conditions for damp and decay. The roof drain serving this roof appeared to be very vulnerable to blockage and overcharging and appeared to receive water from the majority of the roofs to the north and west
- 8 Coping to parapet wall: The parapet wall to the south bay of the main building appeared to be in poor condition with coping and drips allowing water penetration to structures beneath and cracks in the brickwork, indicating chronic water penetration, providing conditions for erosion and decay to structures beneath
- 9 South gable end to north pitched roof: The pitched roof to the north had a cementitious rendered gable end. This appeared to be coming to the end of its useful life, and was likely to allow water penetration during wind driven rain

- 10 Central valley: The central valley of the main building had been repaired using bituminous felts and liquid membranes on previous refurbishment. These had a very limited service life, and it was likely that the valley had allowed chronic water penetration to structures beneath in the past, providing conditions for damp and decay
- 11 Pitched roof over north wing: Pitched roof over the north wing appeared to be of original tiles. These could not be inspected in detail at the time of survey but appeared to be in relatively good condition. However, there were some missing and slipped tiles and inadequate or no provision appeared to have been made for ventilation
- 12 Flat roof at north-east re-entrant corner: There was a small lead flat roof at the north-east re-entrant corner between the main building and north wing. This could not be inspected in detail at the time of survey but appeared to be coming to the end of its useful service life
- 13 Roofs over west ground floor extension: Pitched roofs over the west ground floor extensions generally consisted of slates. These could not be inspected in detail at the time of survey but appeared to have a limited service life and inadequate provision for ventilation. Flashings of adjoining structures were also coming to the end of their useful service life
- 14 Pitched roof over east ground floor extensions or outbuildings: The roofs over the ground floor extensions or outbuildings to the east could not be inspected in detail at the time of survey, but appeared to be in poor condition; especially over the larder or smokehouse
- 15 Access: Access to roofs for inspection and maintenance of roof surfaces and roof drainage systems was limited

3.2 INTERIORS

3.2.1 Roofs

- 1 Flat roof over mill tower: The flat roof over the mill tower appeared to be an original second floor structure, supported on the softwood corner posts of the tower, with main beams approximately 210 x 230mm. The main beams had sectional reductions due to historic decay and deathwatch beetle attack; although, no structurally significant or current decay was found at the time of survey as the deep moisture content of these elements were generally below 12 per cent. The sectional reductions were also observed to the timber joists due to historic decay and beetle attack. Although the majority of the of the roof joists were in good condition, the structural adequacy of these elements should be assessed by the Structural Engineer. The structure to the east had been subject to previous remedial treatment and repair with new softwood
- 2 Roof over link building: There was no access to the flat roof over the link building at the time of survey. However, it was apparent this had been subject to problems of water penetration and previous remedial treatments and repairs on previous refurbishments
- 3 Flat roof over south bay of main building: There was no access to timbers supporting the flat roof over the south bay of the main building at the time of survey. However, these had been subject to chronic problems with water penetration from defective roof surfaces and roof drainage and there is evidence of dry rot (*Serpula lacrymans*) infection and decay to structures beneath. Timber elements built in contact with the brickwork of the external walls are therefore very vulnerable to infection and decay, before or after refurbishment

- 4 North pitched roof over the main building: The north pitched roof over the main building is supported with common rafters, approximately 80-90mm x 60-70mm at 380mm centres, collared with ceiling joists of similar dimensions. It was not possible to inspect timbers in detail at the time of survey due to restricted access. However, these appear to have been subject to extensive repair and remedial treatment on previous refurbishment and chronic problems with water penetration in the past, providing conditions for decay. It is therefore probable that bearing ends of common rafters and underlying plates embedded in the brickwork of the external wall to the north had been decayed or partially decayed. The roof was heavily contaminated with dust and debris and contaminated insulation material. This may represent a potential irritant or health hazard to those working on the structure or occupying the building below, during and after refurbishment
- 5 South pitched roof over the main building: The south pitched roof over the main building was supported with common rafters, approximately 110 x 60mm at 400mm centres, collared with ceiling joists approximately 165 x 50mm. These bore onto a valley wall plate, approximately 110 x 150mm and a primary tie beam approximately 140 x 100mm. It was not possible to inspect timbers in detail at the time of survey due to restricted access. However, these appear to have been subject to extensive repair and remedial treatment on previous refurbishment and chronic problems with water penetration in the past, providing conditions for decay. It is therefore probable that bearing ends of common rafters and underlying plates embedded in the brickwork of the external wall to the north had been decayed or partially decayed. The roof was heavily contaminated with dust and debris and contaminated insulation material. This may represent a potential irritant or health hazard to those working on the structure or occupying the building below, during and after refurbishment
- 6 Flat roof at north-east re-entrant: There is no access to the flat roof structure over the north-east re-entrant. However, timber joists supporting the flat roof structure and underlying plates were built in contact with brickwork subject to chronic water penetration from defective roof drainage. This had provided conditions for decay, before and after refurbishment
- 7 Roof over north wing: The roof over the north wing was supported onto softwood sarking boards approximately 150 x 25mm on common rafters approximately 110 x 50mm at 360mm centres, supported on purlins approximately 100 x 150mm and with collars approximately 110 x 50mm. Hip rafters approximately 220 x 40mm and ceiling joists acted as lower collars, approximately 110 x 50mm at 360mm centres. These were supported with sprocket rafters, approximately 110 x 65mm. No evidence of structurally significant or current decay was found on preliminary visual inspection. However, access for inspection of the eaves was limited. The roof was heavily contaminated with dust and debris, including previous chemical remedial treatments and there was evidence of occupancy by bats and inadequate provision had been made for insulation or ventilation on previous refurbishment and insulation was heavily contaminated
- 8 Roof over west ground floor extension: It was not possible to inspect timbers supporting the roof over the west ground floor extension in detail at the time of survey due to lack of access. However, it was apparent that the bearing ends of joists and underlying plates were built in contact with brickwork subject to chronic water penetration from defective roof drainage to the north and south; especially at the re-entrant corners to the east. Inadequate or no provision had been made for insulation or ventilation on previous refurbishment, making the structure vulnerable to intermittent interstitial condensation
- 9 Roofs over north-east ground floor extensions: It was not possible to inspect the roof timbers over the north-east ground floor extensions in detail at the time of survey.

However, the roof over the larder or smoke room was supported with common rafters, approximately 110 x 60mm at 420mm centres, supported on common rafter plate, approximately 80 x 110mm. This was found to have been decayed at the south side of the roof by wet rot, and appeared to no longer be structurally adequate

3.2.2 Windmill

- 1 Lintels: It was not possible to inspect the lintels over the window openings in detail at the time of survey. However, preliminary inspection of representative openings indicated these were generally of timber and the lintel over the north-east ground floor window and over the ground floor entrance door were found to be structurally decayed
- 2 First floor timbers: It was not possible to inspect the first floor timbers in detail at the time of survey. However, these were supported with primary beams spanning north to south, approximately 250 x 270mm with oak joists spanning east to west, bearing on the primary beams and in the masonry of the external walls. No structurally significant decay was detected on preliminary drilling of primary beams. However, the south bearing ends had been subject to previous remedial treatment and re-supported onto brick columns and deep moisture content of north bearing ends were over 20 per cent, which is damp enough for decay to occur. The bearing ends of joists in the west wall were found to have been partially decayed by wet rot and weevil; although it did not appear to be structurally significant on the preliminary drilling
- 3 Vertical posts: It was not possible to inspect all of the vertical posts or spars supporting the mill tower. However, these appear to be supported directly onto the masonry at ground floor level beneath, making them very vulnerable to decay, before and after refurbishment. The bearing end of the north-east spar was found to have been over 50 per cent decayed for 500mm from its base
- 4 Ground floor: The ground floor consisted of softwood boards laid over a cementitious or concrete screed or slab. Existing timber boards had been over 50 per cent decayed by wet rot and were very vulnerable to further decay
- 5 Wall cladding: The walls were generally clad with dry linings. These generally appear to be non-original and/or had been extensively repaired or replaced on previous refurbishments. Cladding at ground floor level was subject to chronic water penetration from the saturated masonry behind and had been subject to intermittent interstitial condensation and mould growth. This represented a potential health hazard to those occupying the building
- 6 Damp-proofing: Inadequate provision had been made for damp-proofing at the base of the walls on the previous refurbishment. This allowed chronic water penetration, resulting in decay described above
- 7 Dry rot: The H+R Rothound dry rot search dog gave positive indications of active dry rot in a number of areas at the time of survey, as shown on diagrammatic plans at Appendix G. This will provide conditions for decay before and after refurbishment in the absence of adequate remedial measures; especially if further water penetration occurs
- 8 Fireplaces and chimneys: The fireplaces at ground and first floor level appeared to be blocked or partially blocked. This would prevent ventilation and drying. The decorative timber fire surround at ground floor level had been subject to chronic water penetration, resulting in wet rot decay
- 9 Ceilings: Ceilings at ground floor level appeared to consist of a mixture of original lath and plaster and previous patch repairs, with a mixture of mineral fibre insulation

materials above. This prevented access for inspection at the time of survey and may contain asbestos fibres

3.2.3 Main building and north wing

- 1 Lintels: It was not possible to inspect lintels over window and door openings in detail at the time of survey. However, preliminary drilling of representative lintels indicated these were generally of softwood in the main building. Lintels over window openings at the south-west corner of the south bay were found to be structurally decayed by dry rot, and lintels in the west wing appeared structurally inadequate. Lintels in the north and west wings were generally found to be of non-timber construction on preliminary drilling.
- 2 Ceilings: Ceilings were not inspected in detail at the time of survey. However, the majority of ceilings appear to have been replaced on previous refurbishments using plasterboard
- 3 Fireplaces: The majority of original fireplaces appeared to be blocked, preventing through ventilation and drying
- 4 Wall cladding: Generally, wall claddings appeared to be non-original and generally consisted of plasterboard laid on previous refurbishments. This had formed unventilated building voids behind dry linings, which had been subject to intermittent interstitial condensation and water penetration resulting in interstitial mould growth. This represented a potential health hazard to those working on or occupying the building
- 5 First floor: It was not possible to inspect first floor timbers in detail at the time of survey. However, the floor structure generally consisted of softwood joists generally spanning east to west and approximate sectional dimensions of 150 x 50mm at 350mm. The bearing ends of the joists were supported in the brickwork of external and spine walls with softwood plates beneath. Floor structure to the south was supported on 2 no. primary beams, spanning north to south, with timber cladding installed on previous refurbishment. These were not accessible for detailed inspection at the time of survey. However, the south bearing end of the west beam was found to have been over 50 per cent decayed and may no longer be structurally adequate. Generally, bearing ends of joists and underlying plates were very vulnerable to decay before and after refurbishment in areas subject to chronic water penetration adjacent to defective roof drainage, as shown on the diagrammatic plans at Appendix G
- 6 Suspended timber floors at ground floor level: There were suspended timber floors at the east side of the ground floor as shown on the diagrammatic plans at Appendix G. These could not be inspected in detail at the time of survey. However, inadequate provision had been made for through and cross ventilation on previous refurbishment and floor structures had been subject to chronic water penetration, providing conditions for decay by wet rot and wood boring weevil. This was found to result in structurally significant decay in a number of areas, when inspected using high-powered fibre optic borescope
- 7 Solid floor structures: The majority of floors had been replaced with solid screeds or slabs on previous refurbishment. It is not clear that any provision had been made for damp-proofing or insulation to these structures and they appeared to be vulnerable to localised moisture and salt penetration, especially at construction joints
- 8 Damp-proofing: There is evidence of chronic water penetration to the base of the walls and foundations in many areas due to bridging of existing provision for damp-proofing and defective ground and surface drainage. Samples were taken from representative

areas, using a low speed drill at about 500mm from floor level to approximately 150mm deep. These were double bagged and returned to the laboratory at H+R for analysis, following the methodology described in BRE Digest 245, so as to determine their gravimetric and hygroscopic moisture content. Many of these were found to be damp or saturated as shown on table at Appendix H and diagrammatic plans at Appendix G indicating failure of the existing provision for damp-proofing

- 9 Ventilation: Inadequate provision had been made for ventilation on previous refurbishment and occupancy. This had provided conditions for intermittent condensation and mould growth. This may represent a potential irritant or health hazard
- 10 Dry rot: The H+R Rothound dry rot search dog gave positive indications of active dry rot in a number of areas at the time of survey, as shown on diagrammatic plans at Appendix G. This will provide conditions for decay before and after refurbishment in the absence of adequate remedial measures; especially if further water penetration occurs
- 11 Staircase: It was not possible to inspect stair timbers in detail at the time of survey. However, although there were no visible signs of structurally significant or current decay, the base of the stairs was supported directly onto damp masonry, making them vulnerable to decay and inadequate provision had been made for ventilation of the building voids at the base of the stairs, making them vulnerable to infestation by wood boring beetle

4 RECOMMENDATIONS

No chemical remedial timber treatments or 'injected damp-proof courses' are required

4.1 EXTERIORS

4.1.1 South elevations

- 1 The mill tower: If existing clapboarding is to be retained on refurbishment, it should be stripped of impermeable paint finishes, inspected in detail and patch repaired as necessary. On refurbishment, highly breathable microporous paint systems should be used. However, consideration should be given to removing existing non-original clapboarding, so as to allow access to the structures behind before conservation, repair and refurbishment. Allowance should then be made for re-cladding the mill with new clapboarding to match the original, including provision for insulation and ventilation to the structure behind
- 2 Roof drainage: Existing provision for roof drainage should be replaced with new high capacity rainwater goods, detailed as described in General Recommendations at section 5 below. Allowance should be made for repair and re-support of all timber elements built in contact with structures adjacent to the rainwater downpipes, so as to minimise the risk of decay on future occupancy
- 3 First floor bay: On refurbishment, existing shingles should be replaced with new to match the original, including provision for insulation, ventilation and vapour checks behind, so as to meet the requirements of future occupancy. Flashings to adjoining structures should also be replaced with new lead flashings and soakers, laid fully in accordance with recommendations in current LSA Guidelines
- 4 Windows: The existing windows should be inspected in detail to determine their date and condition. If existing windows are to be retained; they should be stripped of impermeable paint finishes, inspected in detail, patch repaired as necessary, and reinstated using highly breathable microporous paint systems and repaired with provision for sash weights, window catches and draughtproofing; so as to facilitate 'background ventilation' on future occupancy. Consideration should be given to providing shutters, double glazing and secondary glazing as necessary, so as to improve U-values on future occupancy. H+R can advise further after detailed investigation if required
- 5 Gable end to main house: Timber elements at the gable end to the main house should be stripped of impermeable paint finishes and inspected in detail when full access is available. Allowance should be made for replacement of clapboarding to match the original and for localised repair to plates adjacent to defective roof drainage, as described at 2 above. On refurbishment, timber elements should be painted with a highly breathable microporous paint system, so as to allow long term drying and provision should be made for ventilation to allow dissipation of water from wind driven rain

- 6 Façade to main house: Facades to the main house should be inspected in detail when full access is available. Allowance should be made for re-pointing throughout, using appropriate remedial lime mortars. The significance of cracking to the brickwork and masonry should be determined by the Structural Engineer. Allowance should be made for repairing brickwork and masonry, and for providing additional support to the foundations as directed by the Structural Engineer
- 7 Masonry base to mill tower: The masonry base to the mill tower should be inspected in detail by H+R and the Structural Engineer when full access is available. Allowance should be made for removing existing cementitious mortar flashing at first floor level and for extensive repair and re-pointing of original masonry, using appropriate remedial lime mortars. Allowance should be made for forming new flashing at first floor level, using appropriate lime mortars, and/or lead flashings laid in accordance with recommendations in LSA Guidelines. Structural significance of cracks and settlement to the masonry should be determined by the Structural Engineer. Allowance should be made for underpinning and/or stabilisation of masonry as directed by the Structural Engineer
- 8 Vents at base of wall: Existing vents should be removed and masonry made good. Alternatively, vents should be re-detailed, so as to minimise water penetration to allow through ventilation into dry linings to the interior. H+R can advise further on detailing if required
- 9 Damp-proof course: Existing provision for damp-proofing should be reviewed in detail following the methodology described in BRE Digest 245, when full access is available. No injection of 'chemical damp-proof course materials' is required. However, ground levels should be reduced to at least 150mm below the level of the original damp-proof course and provision should be made for a 'vertical damp-proof course detail' across the floor/wall junction behind dry lining to the interiors. H+R can advise further after detailed investigation when required
- 10 Ground levels: Consideration should be given to reducing ground levels to at least 300mm below internal floor levels at an early stage during enabling or refurbishment works. On refurbishment, finished landscaped ground levels should be reduced to 150mm below internal floor levels where possible. Where ground levels are above this level, special provision should be made for damp-proofing and ground and surface drainage; especially at thresholds to door openings. H+R can advise further if required
- 11 Ground and surface drainage: Existing provision for ground and surface drainage should be inspected using CCTV and cleared as necessary. Consideration should be given to making provision for temporary ground and surface drainage around the building, so as to drain water clear of the structure during proposed refurbishment works. This may be done in conjunction with reducing ground and surface drainage as described above. On refurbishment, new provision should be made for ground and surface drainage throughout, so as to drain water clear of the base of the walls and foundations; especially at the base of rainwater downpipes. Ground and surface drainage should be inspected using CCTV and 'certified as clear' by the project managers at completion
- 12 Bay link structure: Consideration should be given to providing temporary support to the bay structure forming a link at first floor level, as directed by the Structural Engineer. On refurbishment, timbers supporting the bay should be inspected in detail by H+R and the Structural Engineer and allowance should be made for re-supporting bearing ends of the primary beam in the masonry of the mill and main building to the east and west as directed by the Structural Engineer, ensuring timber elements are re-supported isolated from the masonry with a damp-proof material. Similarly, the base of timber posts should be repaired as directed by the Structural Engineer and re-supported with provision for damp-proofing and flashing, so as to shed water clear of the structures

beneath

- 13 'Mill stone' paving: The original mill stone paving at the base of the timber posts supporting the bay link structure should be carefully recorded and lifted. Consideration should be given to reversing and re-laying as necessary, so as to preserve this original feature and provide safe and adequate footing for future occupancy. H+R can advise further if required

4.1.2 East elevations

- 1 Roof drainage: Existing provision for roof drainage should be replaced with new high capacity eaves gutters and rainwater downpipes, detailed as described in General Recommendations at section 5 below
- 2 Facades: Masonry façade of the main building should be inspected in detail when full access is available. Allowance should be made for removing existing cementitious mortar pointing and re-pointing with new remedial lime mortars throughout to match the original. Allowance should also be made for localised repair to the masonry in areas of heavy erosion and cracking as directed by the Structural Engineer
- 3 Windows: The existing windows should be inspected in detail to determine their date and condition. If existing windows are to be retained; they should be stripped of impermeable paint finishes, inspected in detail, patch repaired as necessary and reinstated using highly breathable microporous paint systems and repaired with provision for sash weights, window catches and draughtproofing, so as to facilitate 'background ventilation' on future occupancy. Consideration should be given to providing shutters, double glazing and secondary glazing as necessary, so as to improve U-values on future occupancy. H+R can advise further after detailed investigation if required
- 4 Damp-proof course: Existing provision for damp-proofing should be reviewed in detail following the methodology described in BRE Digest 245, when full access is available. No injection of 'chemical damp-proof course materials' is required. However, ground levels should be reduced to at least 150mm below the level of the original damp-proof course and provision should be made for a 'vertical damp-proof course detail' across the floor/wall junction behind dry lining to the interiors. H+R can advise further after detailed investigation when required
- 5 Ground levels: Consideration should be given to reducing ground levels to at least 300mm below internal floor levels at an early stage during enabling or refurbishment works. On refurbishment, finished landscaped ground levels should be reduced to 150mm below internal floor levels where possible. Where ground levels are above this level, special provision should be made for damp-proofing and ground and surface drainage; especially at thresholds to door openings. H+R can advise further if required
- 6 Ground and surface drainage: Existing provision for ground and surface drainage should be inspected using CCTV and cleared as necessary. Consideration should be given to making provision for temporary ground and surface drainage around the building, so as to drain water clear of the structure during proposed refurbishment works. This may be done in conjunction with reducing ground and surface drainage as described above. On refurbishment, new provision should be made for ground and surface drainage throughout, so as to drain water clear of the base of the walls and foundations; especially at the base of rainwater downpipes. Ground and surface drainage should be inspected using CCTV and 'certified as clear' by the project managers at completion
- 7 East elevation of north wing: Brickwork and pointing should be inspected in detail when

full access is available. Allowance should be made for localised patch repair using appropriate remedial lime mortars. H+R can advise further after detailed investigation when required

- 8 Ground floor extension: If these structures are to be retained on refurbishment for historic reasons, allowance should be made for carefully recording and disassembling the larder or smoke house to the east and reconstructing with salvaged materials to match the original
- 9 Boundary wall to east: The boundary wall to the east should be inspected in detail when full access is available. Allowance should be made for carefully recording the existing structure and re-building throughout using salvaged materials and appropriate remedial lime mortars

4.1.3 North elevation

- 1 Roof drainage: Existing provision for roof drainage should be replaced with new high capacity eaves gutters and rainwater downpipes, detailed as described in General Recommendations at section 5 below
- 2 Façade: Brickwork and pointing should be inspected in detail when full access is available. Allowance should be made for localised patch repair using appropriate remedial lime mortars. H+R can advise further after detailed investigation when required
- 3 Windows: The existing windows should be inspected in detail to determine their date and condition. If existing windows are to be retained; they should be stripped of impermeable paint finishes, inspected in detail, patch repaired as necessary and reinstated using highly breathable microporous paint systems and repaired with provision for sash weights, window catches and draughtproofing, so as to facilitate 'background ventilation' on future occupancy. Consideration should be given to providing shutters, double glazing and secondary glazing as necessary, so as to improve U-values on future occupancy. H+R can advise further after detailed investigation if required
- 4 Damp-proof course: Existing provision for damp-proofing should be reviewed in detail following the methodology described in BRE Digest 245, when full access is available. No injection of 'chemical damp-proof course materials' is required. However, ground levels should be reduced to at least 150mm below the level of the original damp-proof course and provision should be made for a 'vertical damp-proof course detail' across the floor/wall junction behind dry lining to the interiors. H+R can advise further after detailed investigation when required
- 5 Ground and surface drainage: Existing provision for ground and surface drainage should be inspected using CCTV and cleared as necessary. Consideration should be given to making provision for temporary ground and surface drainage around the building, so as to drain water clear of the structure during proposed refurbishment works. This may be done in conjunction with reducing ground and surface drainage as described above. On refurbishment, new provision should be made for ground and surface drainage throughout, so as to drain water clear of the base of the walls and foundations; especially at the base of rainwater downpipes. Ground and surface drainage should be inspected using CCTV and 'certified as clear' by the project managers at completion
- 6 Ground levels: Consideration should be given to reducing ground levels to at least 300mm below internal floor levels at an early stage during enabling or refurbishment works. On refurbishment, finished landscaped ground levels should be reduced to

150mm below internal floor levels where possible. Where ground levels are above this level, special provision should be made for damp-proofing and ground and surface drainage; especially at thresholds to door openings. H+R can advise further if required

- 7 Vents at base of wall: If a suspended floor structure is to be retained on future refurbishment, existing vents should be replaced with new vents to match the original, detailed so as to provide at least 1,500mm² of vented area per metre of external wall and 500mm² of vented area per metre squared of floor surface; fully in accordance with the requirements of current Building Regulations. H+R can advise further on detailing if required. Alternatively, existing vents should be removed or re-detailed, so as to provide ventilation behind insulated vented dry lining, as described above

4.1.4 West elevations

- 1 Roof drainage: Existing provision for roof drainage should be replaced with new high capacity rainwater goods as described in General Recommendations at section 5 below
- 2 The mill tower to south: If existing clapboarding is to be retained on refurbishment, it should be stripped of impermeable paint finishes, inspected in detail and patch repaired as necessary. On refurbishment, highly breathable microporous paint systems should be used. However, consideration should be given to removing existing non-original clapboarding, so as to allow access to the structures behind before conservation, repair and refurbishment. Allowance should then be made for re-cladding the mill with new clapboarding to match the original, including provision for insulation and ventilation to the structure behind
- 3 Façade on main building: All brickwork and pointing should be inspected in detail when full access is available. Allowance should be made for extensive repair and re-pointing using appropriate remedial lime mortars
- 4 Windows: The existing windows should be inspected in detail to determine their date and condition. If existing windows are to be retained; they should be stripped of impermeable paint finishes, inspected in detail, patch repaired as necessary and reinstated using highly breathable microporous paint systems and repaired with provision for sash weights, window catches and draughtproofing, so as to facilitate 'background ventilation' on future occupancy. Consideration should be given to providing shutters, double glazing and secondary glazing as necessary, so as to improve U-values on future occupancy. H+R can advise further after detailed investigation if required. Allowance should be made for replacing casement windows of ground floor extensions with new to match the original
- 5 Clapboarding of façade of link at first floor level at the south end of the elevation: On refurbishment, the timber frame and clapboarded structure at first floor level forming a link between the main building and mill tower should be fully exposed and inspected in detail. Allowance should be made for repairing timber elements and replacing flashings at junction with the structures to the east and west. Similarly, allowance should be made for extensive repair or replacement of existing clapboarding with new to match the original, including provision for insulation and ventilation to structures behind to meet the requirements of current Building Regulations
- 6 Masonry base to mill tower: The masonry base to the mill tower should be inspected in detail by H+R and the Structural Engineer when full access is available. Allowance should be made for removing existing cementitious mortar flashing at first floor level and for extensive repair and re-pointing of original masonry, using appropriate remedial lime mortars. Allowance should be made for forming new flashing at first floor level, using appropriate lime mortars and/or lead flashings, laid in accordance with

recommendations in LSA Guidelines. Structural significance of cracks and settlement to the masonry should be determined by the Structural Engineer. Allowance should be made for underpinning and/or stabilisation of masonry as directed by the Structural Engineer

- 7 Damp-proof course: Existing provision for damp-proofing should be reviewed in detail following the methodology described in BRE Digest 245, when full access is available. No injection of 'chemical damp-proof course materials' is required. However, ground levels should be reduced to at least 150mm below the level of the original damp-proof course and provision should be made for a 'vertical damp-proof course detail' across the floor/wall junction behind dry lining to the interiors. H+R can advise further after detailed investigation when required
- 8 Ground levels: Consideration should be given to reducing ground levels to at least 300mm below internal floor levels at an early stage during enabling or refurbishment works. On refurbishment, finished landscaped ground levels should be reduced to 150mm below internal floor levels where possible. Where ground levels are above this level, special provision should be made for damp-proofing and ground and surface drainage; especially at thresholds to door openings. H+R can advise further if required
- 9 Ground and surface drainage: Existing provision for ground and surface drainage should be inspected using CCTV and cleared as necessary. Consideration should be given to making provision for temporary ground and surface drainage around the building, so as to drain water clear of the structure during proposed refurbishment works. This may be done in conjunction with reducing ground and surface drainage as described above. On refurbishment, new provision should be made for ground and surface drainage throughout, so as to drain water clear of the base of the walls and foundations; especially at the base of rainwater downpipes. Ground and surface drainage should be inspected using CCTV and 'certified as clear' by the project managers at completion
- 10 Garden wall to west: Masonry, pointing and flashing of the garden wall to the west should be inspected in detail when full access is available. Allowance should be made for extensive repair using appropriate remedial lime mortars. H+R can advise further if required

4.1.5 Roofs

- 1 Chimney pots and flues: All chimneys should be opened and cleared from top to bottom. All redundant flues should be capped, so as to minimise water penetration but allow continued through ventilation
- 2 Chimneystacks: All chimneystacks should be inspected in detail when full access is available. Allowance should be made for re-flaunching and pointing, using appropriate remedial lime mortars and for replacing flashings and soakers to adjoining structures with new lead, laid fully in accordance with recommendations in current LSA Guidelines
- 3 Mill roof: Consideration should be given to replacing existing flat roof to the mill with a new roof surface. Consideration may be given to forming a 'viewing platform' and/or extending the mill tower to match the original, as directed by a Structural Engineer
- 4 Flat roof over link structure or bay: Allowance should also be made for replacing existing flashings and soakers with new and for provision of insulation and ventilation to meet the requirements of current Building Regulations
- 5 Pitched roof over north side of main building: The roof surface should be inspected in detail to determine its condition and service life. Allowance should be made for re-

laying with new throughout, including provision for ventilation at eaves and the ridge as a 'insulated and cold roof structure', fully in accordance with the requirements of current Building Regulations

- 6 Pitched roof over south side of main building: The roof surface should be inspected in detail to determine its condition and service life. Allowance should be made for re-laying with new throughout, including provision for ventilation at eaves and the ridge as a 'insulated and cold roof structure', fully in accordance with the requirements of current Building Regulations
- 7 Flat roof over south bay of main building: Flat roof surface over the bay at the south end of the main building should be replaced with new throughout, including new flashings. Provision should be made for insulation and ventilation of the roof structure by making a continuous flashing vent detail to parapet, in conjunction with provision for ventilation to the adjoining roofs to the south. Provision for roof drainage should similarly be reviewed and re-detailed as described in General Recommendations at section 5 below
- 8 Coping to parapet wall: Parapet should be inspected in detail when full access is available. Allowance should be made for repair and re-building if necessary, as directed by the Structural Engineer and making new provision for damp-proofing, drips and flashings. Alternatively, consideration should be given to overflashing the parapet coping with lead, laid fully in accordance with recommendations in current LSA Guidelines
- 9 South gable end to north pitched roof: Rendered gable end should be inspected in detail when full access is available. Allowance should be made for replacing with new, using appropriate remedial lime renders, in conjunction with repair and replacement of the adjoining pitched and flat roof surfaces
- 10 Central valley: Allowance should be made for re-laying the central valley, using a suitable surface, durable enough to cope with temperature fluctuations and access for maintenance. Consideration should be given to using suitable gauged lead, laid fully in accordance with recommendations and current LSA Guidelines, and provision should be made for ventilation of adjoining pitched roofs as described above
- 11 Pitched roof over north wing: Pitched roof surfaces should be inspected in detail when full access is available, so as to determine its condition and probable service life. Allowance should be made for re-laying throughout with new or salvaged tiles to match the original and including provision for insulation and ventilation as an 'insulated and ventilated cold roof structure' fully in accordance with requirements of current Building Regulations
- 12 Flat roof at north-east re-entrant corner: The roof surface should be inspected in detail when full access is available, so as to determine its condition and service life. Allowance should be made for re-laying with new lead, following the recommendations in current LSA Guidelines and including provision for insulation and ventilation as an 'insulated and ventilated cold roof structure' fully in accordance with requirements of current Building Regulations
- 13 Roofs over west ground floor extension: The roof surface should be inspected in detail to determine its condition and service life. Allowance should be made for re-laying with new throughout, including provision for ventilation at eaves and the ridge as a 'insulated and cold roof structure', fully in accordance with the requirements of current Building Regulations
- 14 Pitched roof over east ground floor extensions or outbuildings: Roofs should be inspected in detail when full access is available. Allowance should be made for re-

laying with new throughout, including provision for insulation and ventilation as 'insulated and through ventilated cold roofs', fully in accordance with requirements of current Building Regulations. Consideration should be given to replacing structures beneath

- 15 Access: Provision should be made for safe and convenient access to all roofs and roof drainage systems, so as to facilitate inspection and maintenance on future occupancy. Consideration should be given to installing automatic electronic radio telemetric gutter water level monitoring alarm systems as an aid to facilities managers. H+R can advise further if required

4.2 INTERIORS

4.2.1 Roofs

- 1 Flat roof over mill tower: The structural adequacy of existing timbers to carry the loads to be expected during and after refurbishment should be determined by the Structural Engineer. H+R can advise further after visual in-situ strength grading if required. Allowance should be made for repairing and re-supporting joints between existing timber elements and providing additional support as necessary. This may be done by partnering with steel and/or forming structural diaphragms in conjunction with re-cladding the external walls as described at 4.1.1 (1) above
- 2 Roof over link building: If this structure is to be retained on refurbishment, roof timbers should be fully exposed by lifting roof surfaces and/or removing ceilings and soffits beneath. Timber elements should then be inspected in detail by deep drilling and probing, so as to determine their decay state and deep moisture content at that time. Allowance should be made for re-supporting timber elements isolated from the masonry of the main building with a damp-proof material and/or through ventilated air gap, using a detail specified by the Structural Engineer and approved by H+R. Similarly, allowance should be made for provision of insulation and ventilation to roof structure in accordance with requirements of current Building Regulations. H+R can advise further after detailed investigation if required
- 3 Flat roof over south bay of main building: If this structure is to be retained on refurbishment, roof timbers should be fully exposed by lifting roof surfaces and/or removing ceilings and soffits beneath. Timber elements should then be inspected in detail by deep drilling and probing, so as to determine their decay state and deep moisture content at that time. Allowance should be made for re-supporting timber elements isolated from the masonry of the main building with a damp-proof material and/or through ventilated air gap, using a detail specified by the Structural Engineer and approved by H+R. Similarly, allowance should be made for provision of insulation and ventilation to roof structure in accordance with requirements of current Building Regulations. H+R can advise further after detailed investigation if required
- 4 North pitched roof over the main building: All contaminated dust, debris and insulation material should be removed from the roof space. This is likely to require the removal of ceilings and soffits beneath. Those undertaking this task should be provided with appropriate respiratory protection, gloves and protective clothing. Timber elements should then be inspected in detail by deep drilling and probing, so as to determine their decay state and deep moisture content at that time and the structural adequacy of existing timbers to carry the loads to be expected during and after refurbishment should be determined by the Structural Engineer. H+R can advise further after visual in-situ strength grading if required. However, allowance should be made for the repair and re-support of bearing ends of common rafters and underlying plates built in contact with the brickwork to the north, using a detail specified by the Structural Engineer and approved by H+R and provision should be made for through and cross ventilation to the

roof as an insulated and through ventilated cold roof, fully in accordance with the requirements of current Building Regulations

- 5 South pitched roof over the main building: All contaminated dust, debris and insulation material should be removed from the roof space. This is likely to require the removal of ceilings and soffits beneath. Those undertaking this task should be provided with appropriate respiratory protection, gloves and protective clothing. Timber elements should then be inspected in detail by deep drilling and probing, so as to determine their decay state and deep moisture content at that time and the structural adequacy of existing timbers to carry the loads to be expected during and after refurbishment should be determined by the Structural Engineer. H+R can advise further after visual in-situ strength grading if required. However, allowance should be made for the repair and re-support of bearing ends of common rafters and underlying plates built in contact with the brickwork to the north, using a detail specified by the Structural Engineer and approved by H+R and provision should be made for through and cross ventilation to the roof as an insulated and through ventilated cold roof, fully in accordance with the requirements of current Building Regulations
- 6 Flat roof at north-east re-entrant: If this structure is to be retained on refurbishment, roof timbers should be fully exposed by lifting roof surfaces and/or removing ceilings and soffits beneath. Timber elements should then be inspected in detail by deep drilling and probing, so as to determine their decay state and deep moisture content at that time. Allowance should be made for re-supporting timber elements isolated from the masonry of the main building with a damp-proof material and/or through ventilated air gap, using a detail specified by the Structural Engineer and approved by H+R. Similarly, allowance should be made for provision of insulation and ventilation to roof structure in accordance with requirements of current Building Regulations. H+R can advise further after detailed investigation if required
- 7 Roof over north wing: All contaminated dust, debris and insulation material should be removed from the roof void at an early stage during enabling or refurbishment works. This may require the removal of ceilings and soffits beneath. All roof timbers should then be inspected in detail by deep drilling and probing, so as to determine their decay state and deep moisture content at that time and the structural adequacy of existing timbers to carry the loads to be expected during and after refurbishment should be determined by the Structural Engineer. H+R can advise further after visual in-situ strength grading if required. Allowance should be made for localised repair and re-support of bearing ends of rafters and underlying plates in areas of chronic water penetration at the base of valleys, especially to the south. On refurbishment, provision should be made for insulation and ventilation as an 'insulated and through ventilated cold roof structure' fully in accordance with the requirements of current Building Regulations
- 8 Roof over west ground floor extension: If this structure is to be retained on refurbishment, the roof timbers should be fully exposed to allow detailed inspection and repair as necessary. This is likely to require the removal of all ceilings and soffits beneath and/or removal of roof, alternatively this may be done during the re-laying of roof surfaces. The decay state and deep moisture content of the bearing ends of common rafters and underlying plate should be determined by deep drilling and probing when access is available. Allowance should be made for repairing and re-supporting the bearing ends of common rafters and underlying plates as directed by the Structural Engineer, ensuring that timber elements are supported isolated from the brickwork with a damp-proof material, using a detail approved by H+R. On refurbishment, provision should be made for insulation and ventilation of the roof structure, fully in accordance with the requirements of current Building Regulations
- 9 Roofs over north-east ground floor extensions: If these structures are to be retained on refurbishment, the roof timbers should be fully exposed to allow detailed inspection and

repair as necessary. This is likely to require the removal of all ceilings and soffits beneath and/or removal of roof, alternatively this may be done during the re-laying of roof surfaces. The decay state and deep moisture content of the bearing ends of common rafters and underlying plate should be determined by deep drilling and probing when access is available. Allowance should be made for repairing and re-supporting the bearing ends of common rafters and underlying plates as directed by the Structural Engineer, ensuring that timber elements are supported isolated from the brickwork with a damp-proof material, using a detail approved by H+R. On refurbishment, provision should be made for insulation and ventilation of the roof structure, fully in accordance with the requirements of current Building Regulations

4.2.2 Windmill

- 1 Lintels: Consideration should be given to providing temporary support to the structures over the north-east ground floor window and door opening as directed by the Structural Engineer. On refurbishment, lintels over all window and door openings should be inspected in detail by deep drilling and probing, so as to determine their structure, decay state and deep moisture content. Allowance should be made for replacing at least 5 no. with steel or concrete as directed by the Structural Engineer
- 2 First floor timbers: The structural adequacy of existing timbers to carry the loads to be expected during and after refurbishment should be determined by the Structural Engineer. H+R can advise further after visual in-situ strength grading if required. The bearing ends of all primary joists and beams should be inspected in detail by deep drilling and probing when full access is available, so as to determine their decay state and deep moisture content at that time. Allowance should be made for re-supporting all bearing ends as directed by the Structural Engineer, ensuring that timber elements are separated from damp or potentially damp masonry with a damp-proof material, using a detail approved by H+R
- 3 Vertical posts: The vertical posts should be fully exposed and inspected in detail throughout their length when full access is available. Allowance should be made for repairing and/or partnering at the base of the posts, as directed by the Structural Engineer. This may be done using new timber, steel and/or structural diaphragms. However, timber elements should be re-supported isolated from damp or potentially damp masonry with a damp-proof material, using a detail approved by H+R. Consideration should be given to providing temporary support to the base of the north-east post, as directed by the Structural Engineer
- 4 Ground floor: Existing boards should be lifted and set aside for salvage if required for historic reasons. Consideration should be given to lifting existing concrete screeds and slabs and re-laying with new in conjunction with re-support of the foundations in the masonry structure, as directed by the Structural Engineer. Provision should be made for insulation and damp-proofing to floor structure to meet the requirements of current Building Regulations. Consideration should be given to installing underfloor heating, so as to allow long term drying and facilitate sustainable occupancy
- 5 Wall cladding: Existing wall cladding should be inspected in detail, so as to identify any historically original materials. All damaged and non-original claddings should be removed at an early stage during enabling or refurbishment works, so as to allow access to structures behind for inspection, conservation and repair. On refurbishment, new wall claddings should be installed so as to form insulated and through ventilated dry linings, so as to allow the conservation of maximum original fabric and sustainable occupancy
- 6 Damp-proofing: Residual moisture contents of existing fabric should be determined following methodology described in BRE Digest 245. On refurbishment, walls should

be re-clad with insulated and through ventilated dry linings, enclosing a 'vertical damp-proof course detail' formed of a strip of studded plastic damp-proof membrane extending across the floor/wall junction to at least 1m above external ground levels. H+R can advise further on detailing when required

- 7 Dry rot: No chemical remedial timber treatments or wall irrigations are required. However, all practical measures should be taken so as to prevent further water penetration to the structure and all structures in areas subject to water penetration and dry rot (*Serpula lacrymans*) infection should be fully exposed to allow detailed inspection by H+R at an early stage during enabling and refurbishment works. Allowance should be made for repair and re-support of timber elements in these areas as described in General Recommendations at section 5 below
- 8 Fireplaces and chimneys: The decorative timber fire surround at ground floor level should be carefully recorded, removed and set aside for conservation, repair and reinstatement on refurbishment. All fireplaces and chimneys should be opened and cleared of debris, so as to allow inspection, through ventilation and drying. On refurbishment, provision should be made for through ventilation to all flues, so as to allow long term drying
- 9 Ceilings: The structure should be inspected for asbestos containing materials and these should be removed as necessary; fully in accordance with the current Control of Asbestos Regulations. Existing ceilings should be inspected to identify any historic or original materials. All non-original and moisture or decay affected ceilings should be removed at an early stage during enabling and refurbishment works, so as to allow access to structures above for inspection, conservation and repair

4.2.3 Main building and north wing

- 1 Lintels: Consideration should be given to providing temporary support to the structures over the north-east ground floor window and door opening as directed by the Structural Engineer. On refurbishment, lintels over all window and door openings should be inspected in detail by deep drilling and probing, so as to determine their structure, decay state and deep moisture content. Allowance should be made for replacing at least 5 no. with steel or concrete as directed by the Structural Engineer
- 2 Ceilings: The structure should be inspected for asbestos containing materials and these should be removed as necessary; fully in accordance with the current Control of Asbestos Regulations. Existing ceilings should be inspected to identify any historic or original materials. All non-original and moisture or decay affected ceilings should be removed at an early stage during enabling and refurbishment works, so as to allow access to structures above for inspection, conservation and repair
- 3 Fireplaces: All fireplaces and flues should be opened and cleared of debris, so as to allow inspection, ventilation and drying. On refurbishment, all flues should be provided with through ventilation
- 4 Wall cladding: All wall claddings should be inspected to identify any historically important original materials. All non-original cladding should be removed at an early stage during enabling or refurbishment works, so as to allow access to structures behind for inspection, conservation and repair as necessary. On refurbishment, walls should be re-clad, using insulated and through ventilated dry linings. H+R can advise further on detailing if required
- 5 First floor: Consideration should be given to providing temporary support to the south bearing end of the west primary beam in the south-west bay as directed by the Structural Engineer. The bearing ends of all joists and underlying plates should be

inspected in detail when full access is available by deep drilling and probing, so as to determine their decay state and deep moisture content at that time. This may be done by lifting floorboards adjacent to external walls and/or removing ceilings and soffits beneath. The structural adequacy of floor timbers to carry the loads to be expected during and after refurbishment should be determined by the Structural Engineer. H+R can advise further after visual in-situ strength grading if required. Allowance should be made for repairing and re-supporting bearing ends of joists and underlying plates in areas subject to chronic water penetration, using details specified by the Structural Engineer and approved by H+R, ensuring that timber elements are separated from damp or potentially damp brickwork with a damp-proof material and/or through ventilated air gap

- 6 Suspended timber floors at ground floor level: Existing suspended timber floor should be lifted to allow access to structures above for decontamination, inspection and repair. If a suspended timber floor is required on refurbishment, this may be re-laid using new or salvaged timbers to match the original. However, timber elements should be re-supported isolated from damp or potentially damp masonry with a damp-proof material and provision should be made for through and cross ventilation, equivalent to at least 1,500mm² of vented area per metre of external wall and 500mm² of vented area per metre squared of floor surface. This will be problematic given the solid floor structures to the east and consideration should be given to replacing existing suspended timber floor with a non-timber floor, including provision for damp-proofing and insulation in accordance with requirements of current Building Regulations

- 7 Solid floor structures: The structure and condition of solid floors should be inspected in detail when full access is available. Allowance should be made for re-laying with new screeds of slabs throughout or overlaying existing slabs with floating floor structures; including provision for insulation and damp-proofing, fully in accordance with requirements of current Building Regulations. This may be done in conjunction with the re-cladding of walls and installation of damp-proofing, as described above

- 8 Damp-proofing: No injection of 'chemical damp-proof course materials' is required and no application of 'proprietary tanking systems' is needed. However, all structures to be retained on refurbishment should be moisture profiled following the methodology described in BRE Digest 245, so as to determine their gravimetric and hygroscopic moisture content. Allowance should be made for cladding the base of all existing walls, including a 'vertical damp-proof course detail' formed of a strip of studded plastic damp-proof membrane running across the floor/wall junction to, say, 1m above external landscaped ground levels. H+R can advise further on detailing when required

- 9 Ventilation: All visible mould growth should be removed as soon as possible. This may be done by 'wet wiping' using a dilute (10 per cent) solution of sodium hypochlorite or household bleach. Those undertaking this task should be provided with appropriate respiratory protection, gloves and protective clothing. On refurbishment, provision should be made for extraction of moisture laden air at point of source and for 'background ventilation', fully in accordance with the requirements of current Building Regulations. H+R can advise further if required

- 10 Dry rot: No chemical remedial timber treatments or wall irrigations are required. However, all practical measures should be taken so as to prevent further water penetration to the structure and all structures in areas subject to water penetration and dry rot (*Serpula lacrymans*) infection should be fully exposed to allow detailed inspection by H+R at an early stage during enabling and refurbishment works. Allowance should be made for repair and re-support of timber elements in these areas as described in General Recommendations at section 5 below

- 11 Staircase: The adequacy of existing stairs to meet the requirements of current Building Regulations on future occupancy should be determined by the Structural Engineer. If

existing stairs are to be retained on refurbishment, timber elements should be inspected in detail by H+R, by deep drilling and probing, so as to determine their decay state and deep moisture content, and allowance should be made for re-supporting timber elements isolated from the masonry at the base of the stairs with a damp-proof material and/or through ventilated air gap. Provision should also be made for ventilation of building voids beneath stairs. Consideration should be given to removing all ceilings and soffits beneath, so as to allow detailed inspection by H+R and the Structural Engineer

5 GENERAL RECOMMENDATIONS

All new and refurbishment detailing should be assessed for its effect on environmental and structural health. General principles are set out below. Special care is required when introducing new materials, moisture sources or heating and ventilation systems, for example air conditioning

5.1 ROOF AND SURFACE DRAINAGE

5.1.1 Maintenance

All guttering, hopperheads and outlets should be regularly checked and cleared to keep them free of debris, especially during the autumn months

5.1.2 Protection

Hopperheads, gutter outlets and ground gullies should be protected with metal mesh cages so as to prevent blockage and overflow. These should extend higher than the expected water level to reduce the tendency to block and should be easily removable to allow cleaning and maintenance

5.1.3 Overflows

Hopperheads, parapet gutter outlets and valley gutter outlets should be fitted with overflow pipes to drain water clear of the structure in case of blockage. These should be at a level below that at which water would overflow the roof flashings

5.1.4 Roof drainage calculations

Roof drainage calculations should be made to check the adequacy of gutters, drains and downpipes so that their capacities may be increased if necessary during refurbishment. H+R can carry out these calculations if required

5.1.5 Monitoring

The installation of an automatic monitoring and alarm system should be considered to give warning of blockage or overflow in the roof drainage system

5.1.6 Access

Safe and convenient access ladders, safety points and walkboards should be installed to all roof areas to allow proper inspection and maintenance

5.1.7 Pigeons

Feral pigeons should be controlled. H+R can give advice on this if necessary

5.2 VENTILATION

5.2.1 Structural voids

All structural voids within the building should be provided with adequate through ventilation so as to prevent moisture build-up. This must be done with regard to the applicable fire regulations

5.2.2 Chimneys

All chimneys not in use should be capped so as to minimise water ingress but so as to allow maximum ventilation of the flues. Flues should be cleared and cleaned to remove blockages. Fireplaces and chimney breasts should be opened or vented to allow through-ventilation of the flues. This prevents moisture build-up in the flues and helps interior ventilation by the stack effect

5.2.3 Bathrooms and kitchens

All bathrooms and kitchens should be fitted with adequate extractor fan systems. These should run for at least fifteen minutes after occupancy to prevent condensation. The installation of floor drains should be considered in these rooms in case of overflow

5.2.4 Roof spaces

All roof spaces, including flat roof areas and gutter soles, should be provided with adequate through-ventilation. This may occur via the gaps between slates in unsarked pitched roofs. However, flat roofs and pitched roofs with sarking or insulation will require the installation of vents through the roof surfaces or at the eaves and ridges. Insulation material in roof spaces should be kept clear of external walls, gutter soles or timbers in contact with damp or potentially damp masonry

5.2.5 Windows

Windows should be refurbished so as to allow easy and convenient opening and closing by occupants in order to encourage proper ventilation of the building. This is important both for environmental and structural health. Windows should be fitted with security locks so as to allow secure locking in a partially opened position

5.3 STRUCTURAL DETAILING

5.3.1 New timbers

New timbers should be isolated from any damp or potentially damp masonry with a damp proof material or ventilated air gap

5.3.2 Timber repairs

Structurally decayed timbers should be removed or cut back to sound timber unless required for aesthetic reasons. Timbers should then be partnered or spliced as in section 5.3.1 above. If steel plates or hangers are used, they should be detailed so as to allow sufficient ventilated air gaps and drainage to prevent moisture build-up due to condensation. No timber preservation or remedial treatments should be required

5.3.3 Paint finishes

Moisture vapour permeable or 'microporous' paint finishes should be preferred for internal and external surfaces and woodwork. This is especially important on window timbers. To take advantage of the properties of such paints, the complete removal of old alkyd paint systems is recommended. Health and Safety: Special precautions should be taken during surface preparation of pre 1960's paint surfaces as they may contain harmful lead. (Permoglaze MVP System, produced by Akze Nobel Decorative Coatings Ltd, is one example of a suitable opaque high build water-borne moisture vapour permeable paint system, consisting of an MVP primer undercoat and MVP acrylic gloss. There may be other similar products available)

Appendix A

A.1 DRY ROT

Dry rot (*Serpula lacrymans*) belongs to the same group of fungi as most of the common mushrooms and toadstools. Reproduction is by means of spores which are produced in enormous numbers by the fleshy pancake-shaped fruiting body. These fruiting bodies generally only appear when the fungus is stressed or dying off. A well established infestation may produce fruiting bodies more than one metre across and be accompanied by thick layers of rust-coloured spore dust. Each minute spore has an outer coat which affords it some protection against heat and desiccation, and germination has been achieved after a twenty-year latent period. Dry rot spores are ubiquitous and there is no domestic or natural environment entirely free of them. They can be found throughout the environment from high up in the jet stream to the middle of the countryside

Spores will germinate and grow in timber with a moisture content of between 20 and 30 per cent. The fine fungal thread (hypha) digests the cellulose and hemicellulose fractions of the wood, but is unable to attack the structural linings. These remain as a brittle matrix which cracks into cubes under differential stresses. Cuboidal cracking is also a characteristic of many wet rots and does not automatically indicate the presence of dry rot

Fungal hyphae may clump together into a variety of structures known as mycelia which take various forms depending on the surrounding conditions. They may fill a humid cavity as a cotton wool-like mass, or grow across the surface of the timber, as a grey-white skin. Active dry rot has a fresh white or greyish appearance and smells strongly of mushrooms. Distinctive patches of lilac or canary yellow pigmentation are usually present

Some hyphae group together to form conducting strands. These have a fairly impervious outer layer rich in chitin, the major constituent of insect cuticle. The strands, which may reach a centimetre in thickness, are flexible when moist, becoming progressively more brittle as they dry out. Their main function is the conduction of nutrients, through or across inert non-nutrient materials (brickwork etc) to other timbers. Their relatively impervious outer layer, together with an unusual alkaline tolerance, allows them to survive in the mortar layers within masonry and walls. An infested area may be full of dry rot strands. The dry rot fungus may tolerate relatively lower moisture contents and, through this, and other quirks in its biology, is potentially capable of considerable destruction. Realisation of this potential, however, requires a narrow range of environmental conditions and, in practice, several factors restrict growth

Dry rot hyphae may attack timber with a moisture content of about 18 per cent; however, spores would not germinate under these conditions. This moisture content is still 5 to 10 per cent wetter than timber should be in a healthy domestic building, and indicates water penetration or, perhaps, faulty plumbing. There is no evidence that dry rot can 'wet up' timber to any appreciable extent under conditions expected in a healthy building, although this is often claimed. The fine attacking hyphae, unlike the coarse conducting strands, are susceptible to desiccation and dry wood may disperse moisture faster than it can be transported. This means they cannot move through dry masonry and wood or across ventilated cavities

The total breakdown of wood by fungus produces considerable quantities of water. It has been suggested that dry rot can sustain itself on this 'metabolic' water alone. However, in practice, external drying factors disperse the moisture so that favourable conditions can be maintained only in exceptional circumstances such as behind impermeable finishes or in sealed cavities

In order to thrive, dry rot requires a moisture content in timber in excess of 20 per cent, and a relative humidity above 95 per cent. Below these levels the fungus will cease to cause current decay problems. Temperature is also a strong regulating factor, and growth ceases at about 25°C, a temperature frequently exceeded in roof spaces, for example. Large radiators can be particularly lethal to dry rot and measurements of 30°C with 20 per cent relative humidity are not unusual in their immediate vicinity

Dry rot is attacked by many other decay organisms which cause particular damage when the fungus is under stress will eventually destroy it. However, under dry conditions, dead dry rot does not disappear. Strands may eventually darken and the fungal mats may lose their fresh appearance, becoming tinged with brown, and leathery or papery in texture. The decayed wood becomes powdery as it dries, shrinks and distorts, which can be the first sign of decay having occurred behind paint finishes

A.2 WET ROT

Wet rot is caused by a number of basidiomycete fungi of which the most important are *Coniophora puteana* (cellar fungus), *Poria fungi*; *Fibroporia vaillantii*, *Poria placenta*, *Amyloporia xantha*, *Geophyllum trabeum*, *Phellinus contiguus*, *Donkioria expansa*, *Pleurotus ostreatus*, *Asterostroma* and *Paxillus panuoides*. They attack both softwoods and hardwoods causing a darkening of the timber (brown rot) or bleaching (white rot). Wet rot fungi usually occur in persistently damp conditions, needing an optimum moisture content of 50 to 60 per cent. Unlike dry rot, the conducting strands of wet rot fungi do not extend far from their nutrient wood, hence they cannot travel through masonry and brickwork. The fruiting bodies occur rarely in buildings. Wet rot has been known to hollow out giant beams. Wet rot *Coniophora puteana* is responsible for up to 90 per cent of wood decay within buildings but raises less concern than dry rot, possibly because it is more easily controlled by standard building techniques. Some wet rots are also called soft rots as they destroy both cellulose and lignin, leaving the colour of the wood largely unaltered, but producing a soft felty or spongy texture. Soft rot is caused by *Chaetomium globosum* and a number of other fungi also found growing on wet wood in buildings

A.3 WOOD-BORING INSECTS

The common furniture beetle (*Anobium punctatum*) has a life cycle consisting of four stages - egg, larva (which causes all the damage), pupa and adult. The eggs are laid in end grain or in existing flight holes and hatch in 4 to 5 weeks and the new larvae bore directly into the wood. The larvae feed and grow within the wood creating a network of tunnels closely packed with frass (small ellipsoidal pellets). The larvae are whitish, curved, approximately 6mm in length and have well defined dark-brown jaws. When fully grown the larva excavates a small chamber and pupates producing a beetle after 6-8 weeks which bores through a thin layer of wood producing the characteristic emergence holes 1-2mm in diameter. Emergence usually occurs between May and August. The life cycle depends on the condition of the wood, the temperature and humidity. The life cycle usually takes a minimum of 3 years within buildings. Attack is usually confined to the sapwood of softwoods and hardwoods but may occur in the heartwood in timbers such as beech, birch, spruce or in timbers modified by fungal decay. As sapwood only makes up a small cross section of the majority of structural timbers in older buildings, attack is often of little or no structural importance. In most instances of suspected attack, the infestation has died out long ago due to unfavourable environmental conditions. Careful checking is therefore required to establish that living woodworm are present

In cases of active infestation the environmental conditions are often marginal allowing the life cycle to continue but at a very slow rate. Small changes in the environmental conditions can tip the balance against insects. Woodworm attack is often very localised to small areas of high humidity or especially 'palatable' timber and further spread is highly unlikely

In the British Isles, death watch beetle (*Xestobium rufovillosum*) infestations occur most commonly in oak, probably because this wood used to be extensively employed in construction, but infestation can also occur in elm, walnut, chestnut, elder and beech. The life cycle is similar to that of the common furniture beetle but can take many years to complete from one year under experimental conditions, to ten years or more in a building (Ref 11). The hatched larvae wander over the surface of the timber before burrowing into it. When it is fully grown it pupates and changes into the adult beetle which does not emerge until the spring of the following year producing a 3mm diameter hole

In old buildings severe damage can be caused under favourable environmental conditions. Softwoods are occasionally infested where they are in close proximity to damp infected hardwood. Infestation is confined to fungal decayed or damp affected timbers. Many existing cases probably arose from the reuse of infected timbers from demolished buildings and from the use of unseasoned timbers used in their construction. Attack is not confined to the sapwood and often the heartwood is entirely consumed causing severe structural damage. Damage is most severe where ventilation is poor and where timbers are in contact with damp masonry

Death watch beetles are not active fliers. A localised attack of death watch will not automatically spread to the whole house and infest every timber in the building. Lowering of moisture contents of the timber in conjunction with careful observation to determine the level and extent of activity should provide control of the insects. Some severe cases may merit the use of local insecticide treatments as a first aid measure. However, the chemical must be targeted properly or large quantities of toxic pesticides will be used to little effect

Woodworm and death watch beetle infestation will not flourish if the moisture content of timber is below about 14 to 15 per cent. The risk of infestation of insect attack is slight, in timbers with a moisture content at or below 14 per cent and the insect larvae will desiccate below about 12 per cent moisture content. The infestation will eventually die out if the timber moisture content is maintained below this. Healthy roof timbers should have a core moisture content of between 14 to 15 percent, while suspended floor timbers should be between about 11 and 14 per cent. Installation of a central heating system may reduce these moisture contents to about 9 per cent particularly in exposed timbers

It is absolutely necessary to recognise whether an insect infestation is 'active' or 'dead'. The presence of fresh frass (bore dust) in conjunction with damp timbers may be acceptable evidence of active infestation

Appendix B

B.1 PRELIMINARY INSPECTION AND INVESTIGATION

The basis of any investigation is an understanding of building structures and defects and how these may interact to produce the ecological niches in which various decay organisms can thrive. With experience, an initial visual inspection can give a good idea of the areas that will need further study. A check-list for this preliminary investigation includes building defects, significant timber structures and concealed cavities

The condition of concealed timbers may be deduced from the general condition and moisture content of the adjacent structure. Only demolition or exposure work can enable the condition of timber to be determined with certainty and this destroys what it is intended to preserve. A non-destructive approach is therefore required and to help reduce uncertainty, specialist instrumentation and test equipment can be useful. However, it is important to remember that all tests and instruments are only aids to the surveyor, and must be interpreted with experience and care. A slavish reliance on any technique and failure to take into account its limitations is a recipe for disaster. No technique can be 100 per cent accurate or reliable

The techniques that may be used for preliminary investigation include resistance-based timber moisture meters, capacitance masonry moisture detectors, borescopes and Rothounds

B.2 DETAILED INVESTIGATION

The findings from the initial investigations are followed up by more detailed study. The aim is to determine as far as possible the distribution and extent of all significant decay and organisms in the building, the distribution of micro environments predisposed to timber decay and the building defects that cause them. The extent of significant timber decay should also be determined as far as possible. Active decay organisms may not yet have caused significant timber decay. Conversely, there may be significant decay even when the decay organisms that caused it have been dead for many years. This may seem obvious but many expensive 'treatments' are carried out on insect or fungus damaged timber that has not been infected for tens or even hundreds of years. Key factors that may be noted are species and viability of decay organisms, moisture content of materials, ambient relative humidity, and ventilation. Timber species and previous chemical treatments may also be significant

It is important that the results of the investigation are co-ordinated with the building structure bearing in mind the characteristics of particular periods and methods of building. They should also be carefully recorded and quantified where possible. This allows analysis of the results by other experts, reduces the 'grey' area in which disputes of opinion can arise and forms a basis on which future investigations can build. Photography can be especially valuable and may be used when necessary

B.3 ROTHOUNDS

Rothounds are specialist search dogs trained to help find dry rot (*Serpula lacrymans*) in buildings. Rothounds may indicate areas of active dry rot even before they are visible to the naked eye. This will occur if the dry rot is just developing, is inside the substance of the timber, between the timber and another surface or within porous masonry. Such indications may be confirmed by comparing them with measurements of the moisture content of the structure or by the use of a drilled sample. Rothounds will not indicate the remains of dead dry rot infestations

In areas indicated by Rothounds the significant timber structures should be checked for structural decay or high moisture levels. Even if these are not found steps should be taken to reduce moisture levels and increase ventilation. This may be all that is required to stop a developing problem and all that is then required is to check the area in 6 months. For this purpose Hutton + Rostron again favour the Rothounds

1 Capabilities

- a May detect living dry rot (*Serpula lacrymans*) by the scent of the metabolites produced by the fungus
- b May detect the scent of dry rot even when hidden behind panelling, under floors, behind plaster or in other concealed cavities
- c May detect the scent of dry rot at a distance of several metres depending on scenting conditions
- d May detect early dry rot growth before it is detectable by the unaided human eye
- e May discriminate between living or dead dry rot and between dry rot and other fungi instantly
- f Actively search for dry rot in buildings at high speed, covering 20 to 50 rooms in an hour
- g May indicate extent and spread of dry rot infestation
- h Will search small inaccessible areas and roof spaces
- i Will work in furnished and inhabited buildings
- j Totally non-destructive
- k Will work 2-4 hours per day

2 Limitations

- a Trained only to indicate living dry rot, not wet rot or dead dry rot. Will not indicate fruiting bodies on old dead outbreaks of dry rot
- b Indicate the scent of dry rot and the point of maximum scent. This may need interpretation as scent can occasionally be moved by air currents from the point of origin
- c Scent will not travel through impermeable surfaces such as neoprene. However, it may be detected at the edge of an impermeable barrier, eg around the edge of a room with a rubber-backed carpet covering an infected floor
- d Indicate dry rot infection, not decay. Therefore heavily decayed but inactive outbreaks may give a weaker indication than a recent highly active outbreak that has not yet caused significant decay

- e May not work if there is a corrosive or choking dust or vapour. However Rothounds should not be put off by smells and may detect even small amounts of dry rot in the presence of other strong scents

3 Uses

- a Survey of properties prior to purchase, renovation, change of occupancy etc, to quickly check for hidden problems
- b Preliminary survey of properties with suspected decay problems to determine existence and extent of dry rot infestation
- c Survey of properties with known dry rot problems to determine activity and extent of infestation
- d Survey of properties undergoing remedial works to check for additional hidden areas of infestation
- e Survey of properties after remedial works to check for efficiency of treatment
- f Routine survey of properties with past problems thought to be at risk in order to detect recurrence of infestation at an early stage before significant decay can occur
- g Periodic survey of properties with known problems awaiting renovation, to detect 'hot spots' of dry rot activity

These can then be dealt with by 'reactive maintenance' allowing outbreaks to be controlled by minor exposure works and environmental controls. This avoids expensive building or remedial works. Further decay is prevented and infection controlled with significant savings on eventual renovation

B.4 FIBRE OPTIC BORESCOPE EXAMINATION

A technique we have found routinely useful over the last 15 years is the use of fibre optics. We use long reach, fixed side view, rigid borescopes and high power light sources. Although this is comparatively expensive it is essential for getting a clear view across a cavity such as a floor space. It also minimises the time spent and the number of holes drilled. Fibre optic inspection can reveal extensive decay and the consequences of water penetration. However, most wood-destroying fungi will not live on the face of timber which is exposed to air movement because this produces a drying effect. It is always a possibility that a fungus, especially dry rot, is travelling behind a wall plate, for example, and is not detectable from the cavity. Fibre optic inspection may not, therefore, find a minor attack which is developing, but it should indicate where these might be initiated so that faults can be identified and remedied. The siting of inspection holes depends on the points at risk within the room and will usually be located adjacent to balcony floors, flat roofs, cracks in rendering and other points where faults may have resulted in water penetration. Inspection may also be limited in areas of tiled and glued flooring materials and ornate or special wall coverings. Inspection holes are numbered and capped off for future use

B.5 THE MEASUREMENT AND SIGNIFICANCE OF MOISTURE CONTENT

The moisture contents in timber, mortar and plaster are measured by a variety of methods. Timber moisture content might be ascertained by the use of a standard resistance-type moisture probe which measures the moisture content at the surface of the wood. However, this moisture content will be subject to considerable fluctuation, depending on current relative humidity and temperature. A rafter in a roof in summer may, for example, have a moisture content at the surface of 16 per cent which might rise to over 20 per cent in winter. This difference would not necessarily reflect increased water content resulting from a fault in the roof, but might simply be a redeposition of water resulting from a considerable drop in temperature

The condition in the core or subsurface of a timber will remain relatively stable which is why the centre of thick timbers may be preferentially decayed. It is this 'deep' moisture content which must be measured if results are to be meaningful. For this reason a hammer probe with insulated electrodes or deep moisture probe is used to measure the moisture content within the timber. Healthy roof timbers should maintain a stable core moisture content of between about 12 per cent and 16 per cent, whilst suspended floor timbers (excluding ground floors) should be between about 11 per cent and 14 per cent. Central heating will usually reduce this figure to around 9 per cent

Similarly, surface moisture content readings in plaster and mortar are of limited value except for purposes of comparison. A surface capacitance meter may be used on plastered walls. For further investigation absolute measurements of moisture content may be made on site by means of a carbide-type gas pressure meter

Alternatively, samples are taken back to the laboratory in sealed vials, and the moisture contents are measured by the oven and balance method. For this, mortar samples are obtained by drilling holes in the wall and dust from the first inch of each hole is discarded. Dry mortar and plaster should have moisture contents below about 2 per cent. At levels much above this the moisture content of incorporated timbers will exceed 20 per cent and may easily reach levels at which fungal decay is likely

B.6 OTHER TECHNIQUES

Other techniques that may be used include microscopy, laboratory culture, hot wire anemometry and electronic RH measurement. We have also developed special instruments for measuring 'available' water in materials and for ultrasonic detection of timber-boring insects. More exotic techniques may sometimes be useful such as pheromone insect traps, infra red thermography, shortwave radar, automatic weather stations and total building monitoring using specialist data loggers

Appendix C

The most critical factors for the environmental control of decay organisms are available moisture and temperature. The former is dependent on such factors as moisture content, relative humidity, micro-ventilation, and salt content. In simplistic terms it is necessary to correct building defects leading to high moisture contents in timber and to increase ventilation around timber at risk

In practice there are two problems; first it is necessary to identify the significant building defects and then the best techniques must be chosen to control the environment at each point. This may be achieved by analysing the building in terms of moisture sources, moisture reservoirs and moisture sinks

It is not possible to prevent moisture entering a building entirely and often attempts to block the movement of moisture through a building structure using impermeable materials are ineffective. They may also be counter-productive as they can prevent moisture being dissipated, resulting in high moisture levels and decay in adjacent materials. The more effective and robust approach is that used in traditional buildings. Here, porous materials are preferred, and every moisture source is balanced by a moisture sink. Thus ground water may penetrate masonry but is evaporated off before it reaches timber structures. Similarly, water vapour is introduced by occupation, but is ventilated out via windows, chimneys and other passive and active forms of ventilation. Failure to balance a moisture source with an appropriate sink may result in moisture moving into vulnerable materials and eventually causing decay and other problems

Moisture reservoirs occur when a moisture 'source' has not been balanced by a 'sink' and water has accumulated in a porous material. Typical examples of this are to be found when thick masonry walls have been soaked by persistent leaks or when chimney breasts have been filled with rain water from uncapped chimneys. Such reservoirs may take years to dry out, even when the source has been dealt with. As a result they can act as a source of moisture for recurrent timber decay over a long period. A special case of this phenomenon occurs when large quantities of water have been used in fighting a fire

In practice then, each area of decay is associated with a building defect, resulting in an increased moisture source, a blocked or inappropriate moisture sink or a moisture reservoir. The appropriate building measures should then be specified to correct that defect

A common example might be the bridging of a damp proof course by raised ground levels. This will act as a moisture source and may result in decay of timbers in an adjacent floor space. Reducing the ground level will cut off this source and will also provide a sink of moisture by allowing evaporation from the exposed wall. The sub-floor moisture level might also be controlled by increasing the other available moisture sinks. Cleaning pre-existing airbricks or inserting additional sub-floor ventilation would be a common measure. In general it is important to increase evaporative surfaces and avoid obstructing them during refurbishment

Another common example would be a blocked and overflowing parapet gutter acting as a moisture source. This could wet up gutter soles, joist ends and wall plates as well as any other structure in an expanding cone extending from the leak down through the building. Preventing this moisture source may require a number of measures such as increasing the capacity of down pipes, re-lining the gutters and fitting thermostatically controlled trace heating tape to increase free flow of snow melt water

Any failure in a roof finish, gutter or coping will generally result in significant water penetration into the masonry wall beneath, which will then act as a moisture reservoir. Any timber in contact with this reservoir will be at risk of decay as it will tend to 'wick' moisture from the masonry. Steps must therefore be taken to isolate in-contact timber from the masonry using such measures as DPC membranes or joist hangers producing an air gap. It will also be necessary to ensure the timbers are adequately ventilated so that any moisture that is absorbed can be breathed off. Closed cavities or water-impermeable layers over timbers at risk must therefore be carefully searched out and rectified using knowledge of historic methods of construction. Bricked-in lintels and sealed up emulsion-painted sash windows are typical examples of structures at risk in this way

Having cut off the moisture source to a moisture reservoir and protected the 'at-risk' timbers it is next necessary to provide safe 'sinks' for the moisture. This will ensure that the reservoir is dried out in the long term. In some cases the reservoir can be removed entirely, for example damp pugging can be dug out and replaced. In most cases it is a matter of promoting ventilation around a wicking surface on the reservoir and ensuring that the moisture-laden air can be vented to the outside. Dry lining systems can be useful for this purpose as can the good old-fashioned chimney. Raising the temperature will promote the process of wicking and evaporation. General house heating can help but care must be taken to ensure that water vapour is not being 'pulsed' into other parts of the building by a sequence of evaporation and condensation down a temperature gradient. Heating can be especially useful if it is possible to heat the reservoir material itself. We have devised special systems for heating large section timbers and masonry for this purpose but again the old-fashioned fire-place and chimney is very useful

In some cases dehumidifiers can be used in the short to medium term, but care must be taken. They often require special 'tenting' and monitoring so that moisture is removed from the appropriate material and not from the world at large. They also require high air temperatures and high RH's to extract moisture efficiently

In all cases most of the remedial building works that may be required are quite within the capacity of the general contractor. Most are traditional repairs though some may take advantage of new materials or techniques such as dry lining, joist hangers and tanking. New and potentially useful products are coming into the building market all the time, for example, time controlled automatic fans, hollow ventilating plastic skirting boards, plastic masonry drains, roof space ventilating systems and moisture permeable paints. All such products and techniques can be used to help in making the environmental control of timber decay even more efficient and economical. All that is required is careful analysis of each situation and a little scientific understanding

Appendix D

The investigation and building works described in the previous appendices should put a building back into a state of structural and environmental health. The environmental control approach will also mean that a building is less likely to develop problems in the future. This is because the effect of minor building failures should be 'buffered' by the robustness of the systems established. Fortunately most traditional systems are robust in this way. This is why older buildings may tolerate a considerable amount of neglect and abuse before developing severe problems. However, the long-term health of the building will always depend on adequate maintenance. This is no less true of buildings treated with timber preservatives

A detailed investigation carried out as part of an environmental control policy provides an excellent basis on which to plan the most cost effective maintenance program. Indeed the building works required for environmental control are often best integrated into such a program. Short-term 'emergency' measures can be taken to simply halt further decay and measures to replace damaged structures or prevent future problems can be delayed to fit into a longer term plan of works. This flexibility in scheduling work as a result of the environmental approach allows further saving of costs and inconvenience

A maintenance program must also include provision for the routine inspection of all significant parts of the building at appropriate intervals. This should aim to detect and correct problems developing before they cause significant damage. Again the information gained in the investigation can be used to decide on the most cost effective inspection interval

In many cases remote monitoring systems can be very useful in increasing the efficiency and reducing the cost of maintenance programs. They can be especially useful for checking the moisture content of inaccessible timbers in roof spaces, behind decorative finishes and in walls. H+R have developed the Curator building monitoring systems for this proposal

Sensors can be placed at all critical points after the investigation or after the remedial building works. Areas can then be closed up and finishes re-applied, for example sensors may be placed in lintels, joist ends, valley gutter soles or in damp walls to monitor drying. It is important to use enough sensors and to place them with an understanding of the moisture distribution processes because conditions can vary even in a small area. It is these local variations in conditions that produce the environmental niches which decay organisms exploit

If more than 30 sensors are deployed, taking the readings can become onerous and this may result in human error or negligence. In these situations automatic monitoring systems become desirable. H+R have developed a number of specialised 'Curator' data logging systems to do this. With larger systems, the wiring of sensors can also become a problem. For systems requiring 100 or more sensors we can use a 'Curator A' unit working via a single 4-core main cable connecting up any number of nodes, each supporting 4 sensors. This system can be programmed with logging intervals and alarm limits for each sensor and can be read via the telephone system via its own modem. Data from the system can then be analysed using CAD and programs for statistical interpretation on a remote computer

Appendix E

E.1 HAZARD: Irritant dusts

Risk:	disturbance of building material or debris by exposure works, cutting, drilling etc could produce airborne dusts which may be irritant to the skin, eyes, nose and respiratory system, and may be a health hazard if breathed in by workers or others in the area; particular hazards include the disturbance of mineral/glass fibre insulation and/or chemically contaminated dust (resulting from remedial timber treatments) in roof spaces or other voids, the disturbance of materials containing asbestos, especially in boiler rooms, flues and pipework installations and the disturbance or removal of faeces deposited by birds or animals
Reduce risk by:	carrying out a COSHH assessment (the duty of the employer under the COSHH regulations) to determine the health risks and necessary measures to protect employees and others. This may include: correct identification of building materials, if possible before works commence (this may require research into record drawings/specifications for previous building refurbishments/repairs/refits; contacting HSE if the presence of asbestos is suspected; avoiding disturbance of hazardous materials; containment of dust within localised areas of the building by creating dust-proof envelopes; ventilation of working areas (may need to be mechanical and may need filtration for the retention of hazardous particulates); provision by employer and use by the operatives of personal protective clothing, goggles and breathing apparatus/masks suitable for the particular type of dust

E.2 HAZARD: Working in confined spaces

Risk:	there may be a build-up of toxic gases (eg from chemical remedial treatments or from site contamination) or a depletion of oxygen in the atmosphere of a confined space; restricted working space may be awkward and lead to injuries; escape may be difficult, causing overexposure to adverse conditions or delay to medical treatment; communication with persons outside the confined space may be difficult
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Reduce risk by: testing the atmosphere for toxic gases and if present, carrying out a COSHH assessment; providing a supply of fresh air into a confined space, if necessary; ensuring that work only proceeds with at least two persons - at no time should a person work alone in a confined space; ensuring that there are emergency procedures in place before work commences, for rescue from confined spaces

E.3 HAZARD: Collapse: renewal of lintels and beams

Risk: improperly sequenced works during the renewal of decayed roof trusses, rafters, joists or lintels could lead to collapse of structure causing injury to workers or others

Reduce risk by: specifying a correct sequence of propping, removal and replacement of structural members to maintain stability during refurbishment

E.4 HAZARD: Collapse: dangerous structures

Risk: unstable structures which are the result of decay, fire damage, impact damage or partial demolition, could collapse causing injury to workers or others

Reduce risk by: shoring up the structure to ensure its overall stability and prevent loose parts falling off; demolition of parts of an unstable structure which are not to be retained, but only if they are not of historical value and only with instruction from the Supervising Officer. Unstable structures should be made inaccessible to workers and others by means of barricades and warning notices until they have been stabilised/demolished. Barriers to comply with BS 6180:1995 Code of Practice for barriers in and about buildings

E.5 HAZARD: Electricity

Risk: of electrocution by cutting through electric cables

Reduce risk by: locating cables before excavation work or cutting into or drilling the existing building fabric, using a cable locator and cable plans, marking their position and taking precautions to avoid contact with them; supplying all portable tools and equipment with 110v transformers, not 240v; ensuring proper connections to equipment. All temporary electricity installations for construction sites should comply with BS 7375:1996

E.6 HAZARD: Falls from height (over 2 metres): scaffolding

Risk:	undertaking inspections or carrying out work from inadequately designed or erected scaffolding could cause persons to fall or injure themselves or others below
Reduce risk by:	use of properly designed and erected scaffold with adequate access; baseplates to uprights; adequate ledgers, braces, struts, ties; fully boarded platforms; guard rails and toe boards to prevent falls of more than 2 metres; frequent inspections of scaffold. Also personal protection such as safety harness and safety line. Scaffolding to comply with BS 5973:1993 Code of Practice for access and working scaffolds etc

E.7 HAZARD: Falls from height (over 2 metres): ladders

Risk:	undertaking inspections or carrying out work from improperly positioned or inadequately secured ladders could cause persons to fall or injure themselves or others below
Reduce risk by:	use of properly positioned ladders secured at the top, and which project at least 1.07 metres above any landing

E.8 HAZARD: Falls from height (over 2 metres): flat roof

Risk:	inadequate edge protection can allow persons to fall off the edge of a flat roof or through openings or fragile roof coverings
Reduce risk by:	installation of edge protection such as guard rails around the perimeter of flat roofs, and around openings or areas of fragile roof coverings within flat roofs; providing safe walkways, platforms, travelling gantries across fragile roofs. Barriers to comply with BS 6180:1995 Code of Practice for barriers in and about buildings

E.9 HAZARD: General

Risk:	general accidents in the course of work such as cuts, impacts, muscular strains etc
Reduce risk by:	providing first aid facilities; providing welfare facilities; providing personal protective equipment and ensuring that the workers use it; ensuring adequate lighting of all access areas and work areas; ensuring that emergency procedures are in place prior to site work commencing

Appendix F



Fig 1:

The Mill as seen from the south; showing original mill building to south-west and house to east. Note structure very vulnerable to wind driven rain due to exposed coastal location and evidence of extensive repair and re-detailing on previous refurbishment, in an attempt to minimise water penetration. Also note ground levels generally at or above internal floor levels with ground and surface drainage tending to drain water into the base of the walls and foundations, especially from the west



Fig 2:

Original mill structure as seen from the south; showing timber mill clad with softwood tongue and groove boarding in the 20th Century and painted with relatively impermeable paint. Also showing knapped flint masonry walls at ground floor level, subject to chronic water penetration and plant growth and with what may be structurally significant cracking

H+R

The Mill, Climping
Photographs
31 May and 1 June 2017
Not to scale

Hutton + Rostron Environmental Investigations Ltd, Netley House, Gomshall, Surrey, GU5 9QA



Fig 3:

South elevation of mill; showing what appeared to be a late 18th or 19th Century window. Note timbers painted with layers of impermeable paint. This had allowed water penetration but restricted drying, providing conditions for localised wet rot decay, especially to the base of external frames and sills. Also note lead flashings installed on previous refurbishments at the end of their useful lives



Fig 4:

South elevation of mill; showing cementitious flashing or flashing on masonry structure at ground floor level, cracked and at the end of its useful life. This is likely to allow water penetration but restrict drying, providing conditions for plant growth, damp and decay. Note cracks in knapped flint structure beneath. This may be structurally significant

H+R

The Mill, Climping
Photographs
31 May and 1 June 2017
Not to scale

Hutton + Rostron Environmental Investigations Ltd, Netley House, Gomshall, Surrey, GU5 9QA



Fig 5:

South elevation of mill; showing relatively narrow, severely dog-legged rainwater downpipe, very vulnerable to blockage and overcharging. This had allowed water penetration to structures beneath, providing conditions for plant growth, damp and decay



Fig 6:

South elevation of mill; showing knapped flint masonry structure at ground floor level, extensively patched in the past with what appeared to be cementitious mortars and severely cracked. This is subject to chronic water penetration, providing conditions for plant growth, damp and decay. Cracking may be structurally significant

H+R

The Mill, Climping
Photographs
31 May and 1 June 2017
Not to scale

Hutton + Rostron Environmental Investigations Ltd, Netley House, Gomshall, Surrey, GU15 9QA



Fig 7:

South elevation of mill; showing threshold to door opening, allowing water to drain back into the structure, providing conditions for wet rot decay to base of external doors and frames. Note ground levels at or close to internal floor levels to south and over 300mm above internal floor levels to the west. Also showing what appeared to be structurally significant cracking to masonry to east



Fig 8:

South elevation; showing central first floor bay. Note timbers painted with layers of impermeable paint. This had allowed water penetration but restricted drying, providing conditions for localised wet rot decay, especially to the base of external frames and sills. Also showing flashings coming to the end of their useful lives and what appeared to be cedar shingles beneath with a limited service life



The Mill, Climping
Photographs
31 May and 1 June 2017
Not to scale

Hutton + Rostron Environmental Investigations Ltd, Netley House, Gomshall, Surrey, GU5 9QA



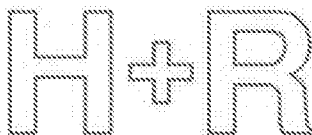
Fig 9:

Centre of south elevation; showing front porch beneath central bay, supported on oak posts



Fig 10:

South elevation; showing base of timber posts, partially decayed by wet rot. They bore onto padstones or pillars beneath. Note previous repairs with concrete. These were very vulnerable to further decay and may no longer be structurally adequate. Also showing original composite mill stones forming paving at base



The Mill, Climping
Photographs
31 May and 1 June 2017
Not to scale

Hutton + Rostron Environmental Investigations Ltd, Netley House, Gomshall, Surrey, GU5 9QA



Fig 11:

Centre of south elevation; showing paving in front porch area, tending to drain water into the base of walls and foundations, especially in the area of the drainage gully to the west. Note ground levels at internal floor level and knapped flint masonry repaired with cementitious mortars on previous refurbishments



Fig 12:

South elevation of house to east; showing brick and knapped flint or beach cobbles facades with pointing repaired with cementitious mortars on previous refurbishments. These will allow water penetration but restrict drying. Also showing windows with timbers painted with layers of impermeable paint. This was allowing water penetration but restricted drying, resulting in wet rot decay to base of external frames and sills. Note ground levels generally above internal floor levels with ground and surface drainage tending to drain water into the base of the walls and foundations

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The Mill, Climping
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Not to scale

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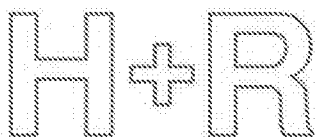
Fig 13:

South elevation; showing gable end with corbelled plates, exposed common rafters and tongue and groove boarding to gable end and barge boards above painted with layers of impermeable paint. This will allow water penetration but restrict drying, providing conditions for wet rot decay but these were not accessible for detailed inspection at the time of survey



Fig 14:

South elevation; showing hopper and rainwater downpipes blocked and discharging water onto structures beneath, providing conditions for plant growth, damp and decay. Also showing settlement cracks in masonry. These may be structurally significant



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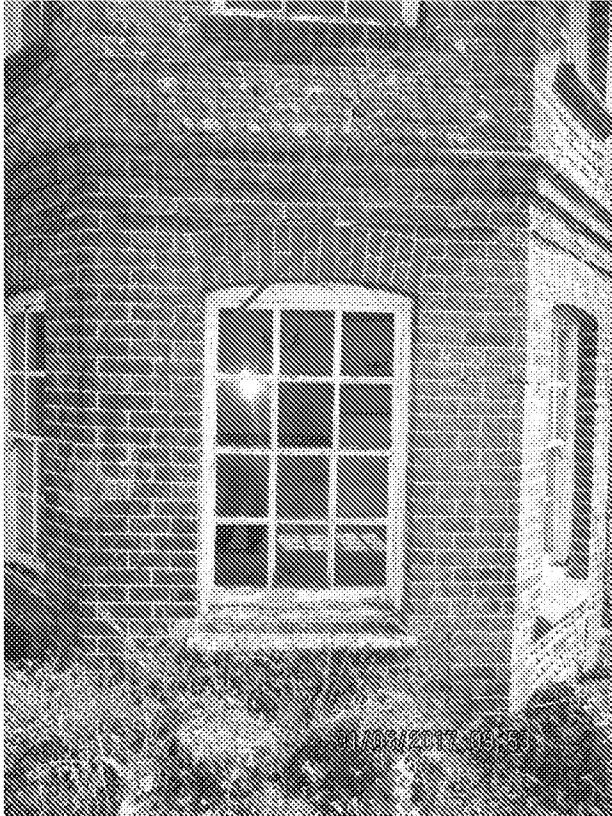


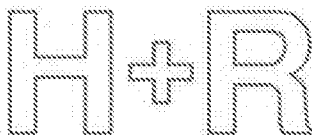
Fig 15:

South elevation; showing settlement cracks in masonry. These appear to be structurally significant. Also showing wet rot decay to window timbers



Fig 16:

South elevation; showing settlement cracks in masonry and wet rot decay to window timbers. Note ground levels above internal floor levels and ground and surface drainage draining water into the base of walls and foundations, especially in the area of the drainage gulley. Note original vent blocked or partially blocked



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Fig 17:

South elevation; showing original vent blocked or partially blocked and pointing repaired using cementitious mortars on previous refurbishment. Also showing slate physical damp-proof course. This had been bridged by raised ground levels to the west



Fig 18:

East elevation of main house; showing façade of knapped flints or beach cobbles, re-pointed with cementitious mortars on previous refurbishment. This may allow water penetration but restrict drying. Also showing ground and surface drainage tending to drain water into the base of the walls and foundations from the east with ground levels generally at or close to internal floor levels

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Fig 19:

East elevation; showing chimneystack with open flues. Also showing haunching, pointing, brickwork and flashings patched with cementitious mortars in the past. This will allow water penetration but restrict drying, providing conditions for further erosion, damp and decay



Fig 20:

East elevation; showing tiled roof surface with many slipped and eroded tiles. These had a very limited service life. Also showing settlement of ridge and roof structure to north. This may be structurally significant



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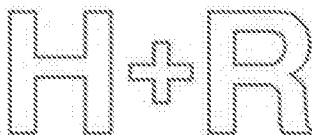
Fig 21:

East elevation; showing relatively narrow eaves gutter blocked by plant growth in the past and with missing sections. This had allowed chronic water penetration to structures beneath in the past, providing conditions for plant growth, damp and decay



Fig 22:

East elevation; showing window timbers painted with layers of impermeable paint. This had allowed water penetration but restricted drying, providing conditions for wet rot decay, especially to the base of external frames and sills



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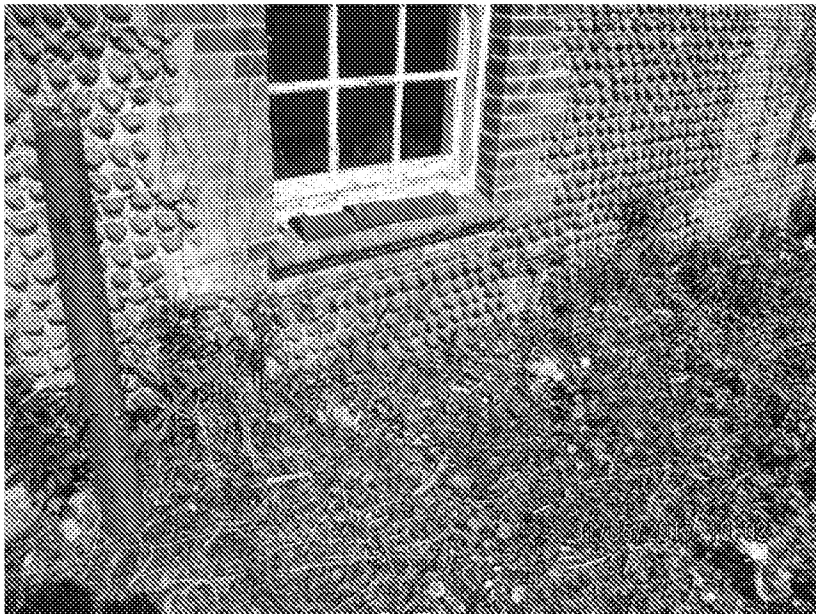


Fig 23:

East elevation; showing re-entrant corner to north wing, showing defective roof drainage, allowing chronic water penetration, providing conditions for plant growth, damp and decay. Also showing cracking in brickwork at first floor level. This may be structurally significant

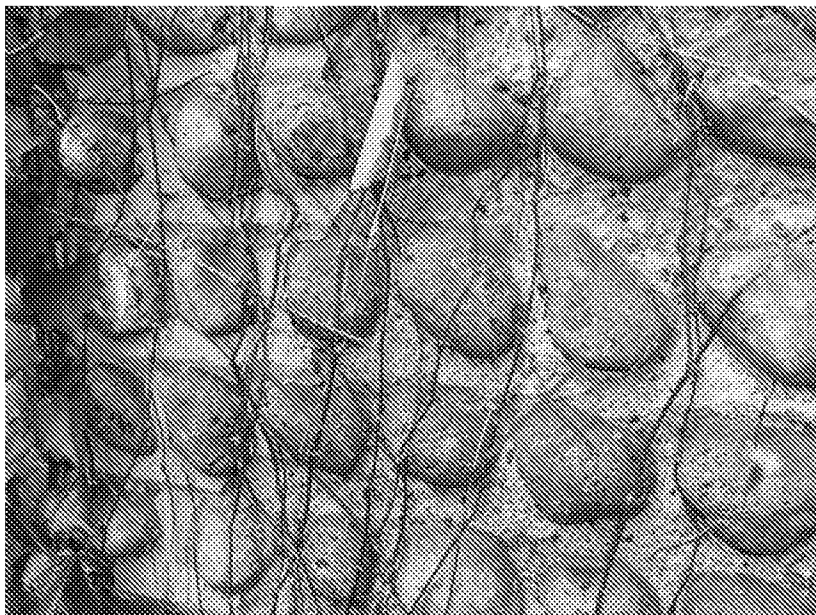


Fig 24:

East elevation of main building; showing what appeared to be original lime and clinker ash mortar pointing overlaid with a thin layer of cementitious mortar pointing on previous refurbishment. This would have a limited service life as well as allowing water penetration but restricting drying, while the original mortar was likely to have high pozzolanic content



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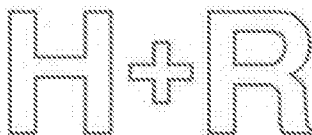
Fig 25:

North end of east elevation of main house; showing eaves gutter and rainwater downpipe replaced with relatively narrow plastic rainwater goods in the recent past, indicating failure of original rainwater goods. This had allowed chronic water penetration to structures beneath, providing conditions for damp and decay from roof to ground level. Also note erosion to pointing due to chronic water penetration in the past. This may be structurally significant



Fig 26:

North elevation of main house at re-entrant corner to north-east; showing original pointing to knapped flints or beach cobbles heavily eroded and localised patch repair, using cementitious mortars. This may be structurally significant



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Fig 27:

East elevation; showing ground levels at or just above internal floor levels with ground and surface drainage allowing water penetration to the base of walls and foundations, providing conditions for damp and decay. Also showing original and supplementary vents at the base of walls, presumably intended to serve sub-floor voids in the past and drainage gullies very vulnerable to blockage and overcharging

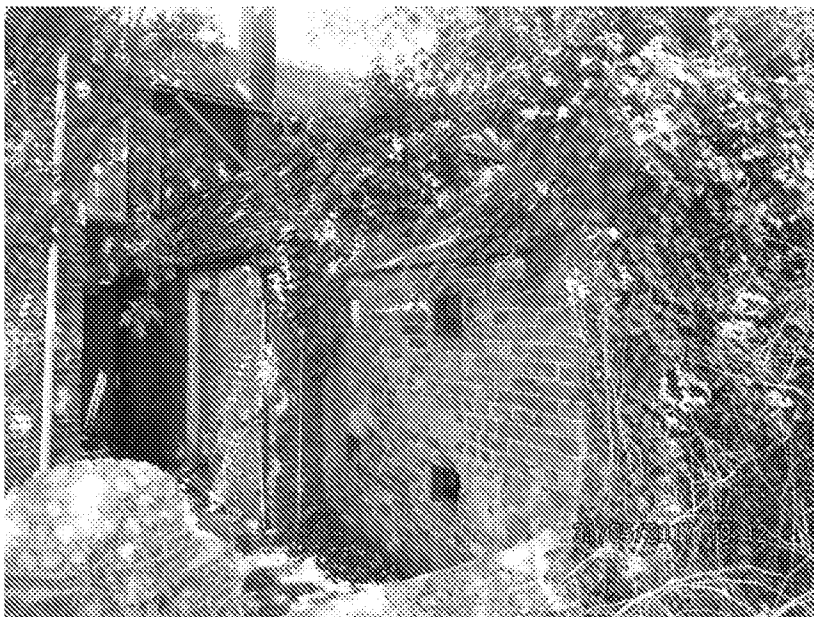
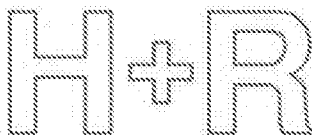


Fig 28:

North end of east elevation; showing ground floor extensions with roofs and masonry in poor condition, allowing water penetration providing conditions for damp and decay



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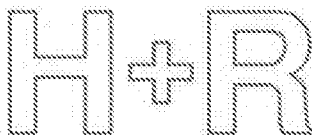
Fig 29:

East elevation; showing 'larder' structure with masonry in poor condition, including settlement cracks, extensive patch repair using cementitious materials in the past and the roof at the end of its useful life. This had allowed water penetration resulting in wet rot and wood boring beetle decay to wall plates and rafters. In particular, note parapet or gable end wall to east. This appeared to be structurally unstable



Fig 30:

East elevation; showing knapped flint or beach cobbles garden wall and posts with pointing heavily patched with cementitious mortars on previous refurbishment. These were allowing water penetration but restricting drying, resulting in accelerated erosion. This may become structurally significant, especially to the north



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Fig 31:

North end of east elevation; showing ground floor extension or outhouses to north-east with roof surfaces and structures apparently at the end of their useful lives and roof drainage allowing chronic water penetration into structures at the re-entrant to the main building at the north wing, providing conditions for damp and decay

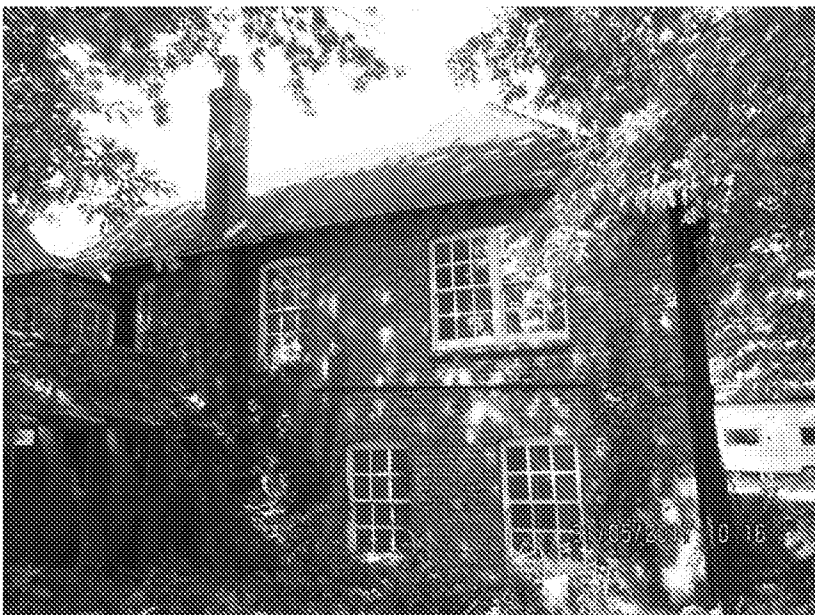


Fig 32:

North end of east elevation; showing pitched roof surface to north wing in relatively good condition. However, note eaves gutter missing, allowing water to discharge onto structures beneath



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Fig 33:

North end of east elevation; showing chimneystack. Note original pointing eroded and original lead damp-proof course at base of stack



Fig 34:

North end of east elevation; showing pitched roof surface to north wing in relatively good condition. However, note eaves gutter missing, allowing water to discharge onto structures beneath



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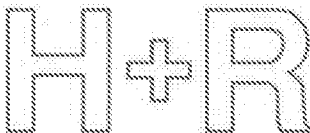
Fig 35:

North end of east elevation to north wing; showing ground levels at or close to internal floor levels with ground and surface drainage tending to drain water into the base of the walls and foundations. Note original physical slate damp-proof course approximately 100mm above existing ground levels. However, also note drainage gullies blocked and draining water into the base of the walls and foundations



Fig 36:

North elevation of north wing; showing roof surfaces in relatively good condition. However, note pointing to chimneystack heavily eroded and roof drainage vulnerable to blockage and overcharging



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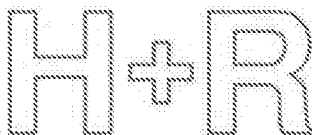
Fig 37:

North elevation of north wing; showing ground and surface drainage allowing water penetration to the base of walls and foundations. Note original physical damp-proof course approximately 100mm above existing ground levels and drainage gulley blocked and overcharging water into the base of walls and foundations



Fig 38:

West elevation of north wing; showing roof surface in relatively good condition with some slipped and damaged tiles. Also note showing roof drainage vulnerable to blockage and overcharging



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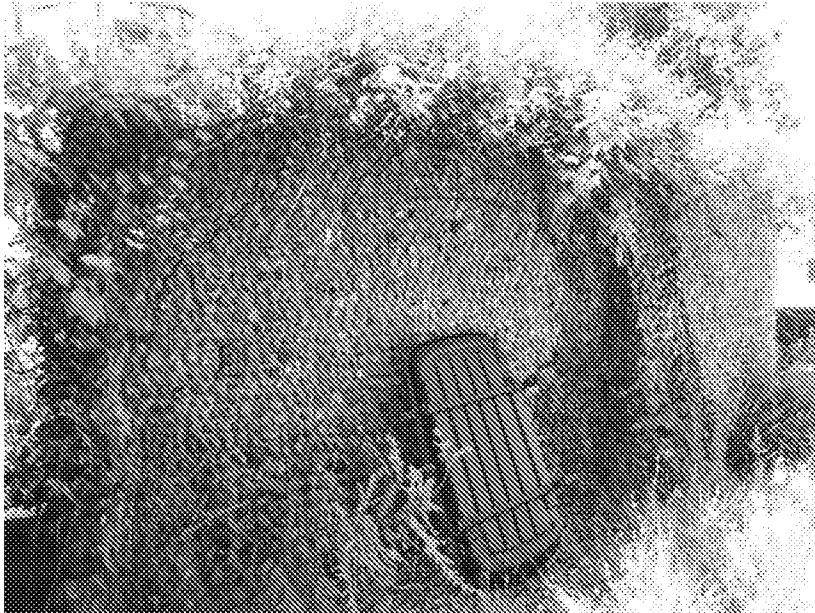


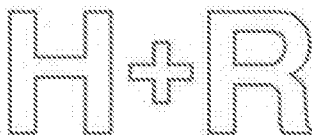
Fig 39:

West elevation; showing knapped flint or beach cobbles garden wall with severe cracking to east. This appeared to be structurally significant



Fig 40:

West elevation of north wing; showing ground and surface drainage allowing water penetration to the base of the walls and foundations, especially around drainage gulley and steps to the south. This had provided conditions for plant growth, damp and decay. Note settlement crack over ground floor window opening. This may be structurally significant



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