The Hill House

Research & Development Project

LDN Architects

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

NATIONAL TRUST *for* SCOTLAND

Getty Foundation

Contributors

Client:
National Trust for Scotland
Hermiston Quay
5 Cultins Road
Edinburgh
EH11 4DF

Architect:
LDN Architects
57-59 Bread Street
Edinburgh
EH3 9AH

Structural Engineer
David Narro Associates
34-36 Argyle Place
Edinburgh
EH9 1JT

Building Services Engineer
Irons Foulner
48 Melvile Street
Edinburgh
EH3 7HF

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1903 Concept sketch from South East

Acknowledgements, Copyright and Abbreviations

Acknowledgements

This Research & Development Project Report was prepared for the National Trust for Scotland by:

Team Leader
Mark Hopton, a Partner in LDN Architects and RIAS Conservation Accredited Architect (Advanced Level) led the study team and authored this report with the assistance of Ian Fraser, RIAS Conservation Accredited Architect (Advanced Level); Fiona MacDonald, RIAS Conservation Accredited Architect; and Amy Redman, Architect and SPAB Scholar who all worked for LDN Architects during the preparation of the study.

Structural Engineer
Steve Wood, a Technical Director of Conservation at David Narro Associates and Conservation Accredited Engineer

Building Services Engineer
Professor Stuart MacPherson, a Director of Irons Foulner Consulting Engineers

Cost Consultant
Alan Harper, a Director of Morham & Brotchie Quantity Surveyors

The following people have also contributed their time and expertise in the preparation of the report and their advice and insights are much appreciated:

Louise Baker, The National Trust for Scotland
Fritha Costain, The National Trust for Scotland
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Sophia Mirashrafi, Historic Environment Scotland
William Napier, The National Trust for Scotland
Andrew Wright, Conservation Architect
Maureen Young, Historic Environment Scotland

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Copyright

Abbreviations

Throughout this report, the following abbreviations are used:

CRM	Charles Rennie Mackintosh
HES	Historic Environment Scotland
NTS	The National Trust for Scotland
RCAHMS	The Royal Commission on the Ancient and Historical Monuments of Scotland, now HES

1.0

Introduction

10 *The Hill House, 2016*

Introduction

The Hill House, designed by Charles Rennie Mackintosh, has suffered from problems associated with water ingress throughout its life as a consequence of the nature and technical performance of the Portland Cement roughcast used by Mackintosh, coupled with the omission of traditional weathering details as a result of his misplaced confidence in the performance of Portland Cement as a water-proofing material.

Successive generations of leading conservation specialists have tried to solve the problems of water ingress. Repair strategies in the past have ranged from wholesale replacement of original fabric to conservation and consolidation, reflecting the best conservation knowledge and principles of their time, and most have resulted in temporary success. Problems have always returned however with the risk of further collateral damage. In some instances, the repairs have replaced original fabric with new and in others the repair processes and materials may have caused significantly more damage than the problems they were intended to solve.

In recent years, a range of detailed investigations have been commissioned by the NTS, who own the building, to provide evidence of extent of the problems. When read together, the investigative reports are remarkably consistent in terms of their conclusions about the problems identified and their underlying causes. They describe a condition which has continued to deteriorate and a situation where the embedded moisture content of the external walls is now so high that the building materials forming the walls can no longer regulate the flow of moisture and are in some areas dissolving: placing the interiors and collections at high risk of damage.

The NTS recognised that a new long-term conservation approach, based on empirical evidence, was required to solve the problems of water ingress and fabric deterioration. Such an approach must protect the Authenticity of CRM's design and must not repeat the errors of previous conservation strategies. In 2015, the NTS therefore advertised for a specialist consultant team to lead a phase of research and development that would establish an appropriate long-term maintenance/repair methodology and materials specification for the external fabric of the property without detriment to its Significance and Authenticity. The work envisaged was to:

- Lead a programme of Research and development that would describe a repair methodology for the external fabric, comprising detailed investigations, science, sample panels and indicative costs.
- Manage a package of immediate protection and repair work.
- Develop ideas for academic engagement and external advisory panels.
- Identify potential project partners from commerce and academia.

A team led by LDN Architects was appointed in 2016 after a competitive selection process. The team included a structural engineer; building services engineer; and cost consultant experienced in the conservation of similar historic properties; and representatives of Glasgow School of Art's Mackintosh Environmental Assessment & Research Unit; the Building Research Establishment; and Heriot-Watt University. Initial work was carried out and it was concluded that the process of water ingress had to be halted to prevent irrevocable damage. This conclusion resulted in the construction of the protective Box in 2019 which has, without doubt, delivered its intended purpose.

Work on the R&D Project was paused during the construction of the Box and further delay was caused by the pandemic in 2020. The Box, however, is only a temporary solution and has a design life of only 10 years. In late 2020, therefore, discussions took place about how to complete the R&D project in the new context of the Box. The result is this report which describes the process by which a conservation strategy for the external fabric of The Hill House should be developed. It does not however pre-judge what that conservation strategy will be.

This report collates existing documentary and survey information; describes our current understanding of the issues affecting the external fabric of The Hill House and proposes a route to identifying a preferred Conservation Strategy together with an Implementation plan for so doing. At the end of the report are recommendations covering:

- Work to Assist Drying Out
- Essential Research and Investigations to Inform Decision-Making
- Preparation of a Detailed Conservation Strategy
- Preparation of the Conservation Implementation Plan
- Conservation Delivery
- Parallel Workstreams

The focus of the Research & Development Project is on the authenticity, condition and performance of the external fabric but decisions about its future cannot be made in isolation and a holistic approach to the whole property is required. As an example, the NTS Interiors Authenticity Report (ref Appendix AC) provides, for the first time, an evidence-based assessment of how the interiors have been affected by water ingress and demonstrates how decisions about repairs to the exterior of the house can have a major impact on the interiors. Decisions about the external fabric should therefore take account of potential impacts on the whole property, including interiors, collections, landscape, boundary walls, gates and ancillary buildings. This report therefore also makes recommendations for additional research covering each of these aspects of the property.

2.0

Executive Summary

The Hill House, 2016

Executive Summary

The Hill House is the most complete and finest example of domestic architecture by the internationally celebrated architect, Charles Rennie Mackintosh. The house has, however, suffered from problems associated with water ingress throughout its life as a consequence of the nature and technical performance of the Portland Cement roughcast used by Mackintosh, coupled with his omission of traditional weathering details on the basis of his misplaced confidence in the performance of Portland Cement as a water-proofing material. The roughcast was originally thought to be impervious to water ingress but history has proven that cracks form as a result of thermal movement within the roughcast and substrates below or through differential movement between different materials. Rain-borne water then penetrates the cracks and is trapped behind the roughcast, migrating towards the interior face of the walls and causing fabric deterioration.

Successive generations of leading conservation specialists have tried to solve the problems of water ingress. Repair strategies in the past have ranged from wholesale replacement of original fabric to conservation and consolidation, reflecting the best conservation knowledge and principles of their time, and most have resulted in temporary success. Problems have always returned however with the risk of further collateral damage. In some instances, the repairs have replaced original fabric with new and in others the repair processes and materials may have caused significantly more damage than the problems they were intended to solve.

Over recent years detailed investigations have been carried out to assess the extent of the problems. When read together, the investigative reports are remarkably consistent in terms of their conclusions about the problems identified and their underlying causes. They describe a condition which has continued to deteriorate and a situation where the embedded moisture content of the external walls is now so high that the building materials forming the walls can no longer regulate the flow of moisture and are in some areas *dissolving*: placing the interiors and collections at high risk of damage.

The objective of this Research and Development project is to describe a conservation planning process by which long-term solutions for the problems of water ingress can be identified and implemented without detriment to the Significance and Authenticity of Mackintosh's design. Such solutions will therefore be dependent on:

- An agreed understanding of the property's Significance & Authenticity;
- A detailed technical, evidence based, understanding of the external fabric condition and its impact on the condition of interiors and collections;
- Identification of an alternative material to the Portland Cement roughcast, originally used as the external wall finish, that actually works to keep water out in the way intended.
- Improvement of the weatherproofing details particularly at wallheads and chimneys in ways that prevent water ingress whilst restoring the Authenticity of Mackintosh's original design.

The project collates existing documentary evidence; describes our current understanding of the water-ingress issues affecting The Hill House; and proposes a route to identifying a preferred Conservation Strategy together with an Initial Implementation Plan for so doing. It describes the conservation planning process by which an appropriate scope of conservation work can be developed but does not attempt to describe what that scope of work should be due to a range of knowledge gaps still to be closed and a concern not to pre-judge outcomes.

On the basis of current knowledge, the report does however conclude that there are four possible conservation strategies for the external fabric of the house. These strategies depend on the condition of the existing wall fabric and whether or not a new roughcast material can be identified to solve the problems of water ingress. Each has different impacts on the significance, authenticity and future maintenance and operation of the property which are still to be investigated:

1. The protective Enclosure is removed and the external fabric conserved as existing using modern Portland Cement alternative.

2. The protective Enclosure is removed and the external fabric restored to its original design using modern Portland Cement alternative.

3. The house is permanently contained within a protective Enclosure and the external fabric is conserved as existing.

4. The house is permanently contained within a protective Enclosure and the external fabric restored to its original design using a Portland Cement based material matching the original specification.

3.0

Brief

LDN Architects
57 - 59 Bread Street, Edinburgh EH3 9AH
T: 0131 222 2900
E: architects@ldn.co.uk

A4 METHODOLOGY: Rev B, 30.11.20
(Based on Burra Charter Conservation Planning Process)

STAGE 1 BASELINE UNDERSTANDING	STAGE 2 FACTORS + ISSUES	STAGE 3 DEVELOP R&D METHODOLOGY	STAGE 4 R&D CONSERVATION MANAGEMENT PLAN
(Based on previous work with additional information gathering workshops) Confirm Question to be answered NTS Ambition Significance & Authenticity Current Fabric + Collections Condition Repairs Timeline Impact of Previous Repairs Impact of Enclosure Comparators Digital Information HES Monitoring & Analysis Knowledge Gaps	(Short / Medium / Long-Term) Water Ingress Causes NTS Requirements Fabric Condition & Performance Environmental Condition & Impacts Significance & Authenticity Comparator Lessons Partner Involvement Consultations, Engagement & Decision-Making Addressing Knowledge Gaps	(Short / Medium / Long-Term) Surveys Analysis Research Programme Costs Partners Digital Strategy Consultation, Engagement & Decision-Making Strategies	(Short / Medium / Long-Term) Objectives & Outcomes Significance & Authenticity Methodology Activities Risks Programme Cost
OUTPUT: STATEMENT OF CURRENT UNDERSTANDING	**OUTPUT:** SCHEDULE OF FACTORS + ISSUES	**OUTPUT:** R&D PLAN	**OUTPUT:** R&D CONSERVATION MANAGEMENT PLAN DESCRIBING REQUIRED PHASE B WORK & BUDGET COSTS

Project Brief

The Project Brief was first issued by the NTS as an invitation to tender in September 2015 and subsequently updated in March 2016. The scope of work was described in Section 2, Project Summary, and stated that:

2.0 Project Summary

The aim of this project is to lead a phase of research and development that will establish an appropriate long term maintenance/repair methodology and materials specification for external fabric of the property. This will be based on a full understanding of research carried out to date and is likely to comprise detailed investigations, materials science, sample panels and involve building performance modelling to aid risk assessment. In addition, following a preliminary assessment of the property, this commission will also include managing the delivery of an initial package of repairs/temporary works to arrest immediate needs at the property, which may include measures to improve the internal environment at the property. It is expected that this commission will be delivered with input from industry and/or with academic peer review. Your proposal should include some ideas or proposals from yourself in this regard.

You should also anticipate that this commission will have a high degree of public visibility with access to the physical monitoring (and subsequent full) restoration process. The presentation of the monitoring process is likely to me made very visible as indeed the decision making process itself. Confirmation of your appetite, interest and any experience in working with interpretation designers is requested.
The commission will comprise the following:

Phase A

1. A desk based review of the property's external and internal repair and research history, alongside establishing an understanding of related modern monuments conservation/ repair approaches. This will be capped at £5,000 with each tenderer asked to demonstrate how this would be used.

2. A detailed study of the property's current condition, construction, junctions and authenticity. This will update existing survey information and identify areas of immediate risk, inherent weakness and previous interventions. The level of survey, investigations, monitoring, and sampling carried out at this stage should be sufficient to update the property's Quinquennial Survey and deliver an immediate repairs/ temporary protection package to limit areas of need. You will use the investigation results from Phase A to recommend and fully cost the more intensive/invasive techniques to be undertaken as part of the proposed Phase B and justify their inclusion in the concluding Phase A:4 Report.

3. Upon completion of A:2, act as Contract Administrator/ Principal Designer to deliver an agreed package of repairs/ temporary protection to address these risks. Areas of current concern include; the south and west elevations which are continually affected by the effects of wind driven rain, chimneys, solum/ground drainage, short-term environmental control, temporary protection. This should tendered as a lump sum fee as per the pricing schedule.

4. Present detailed proposals for a Phase B package of continued investigations, analyses, testing, sample panels, ongoing temporary protection, monitoring and modelling. This will ultimately inform the repair and maintenance strategy for the whole property, including House exteriors and interiors, and areas affected by external drainage issues. Internally, investigations should consider structural issues and the internal environment, and both their roles in safeguarding the fabric, interiors and collection. The proposal will build upon the initial investigations carried out within A:2 by recommending specific further investigative techniques, materials testing and sample panels and monitoring to inform future repair approaches and materials specification for both external fabric and internal environmental improvements. The proposal should be presented in the format of a detailed report and be supported by the conclusions of any new analysis work undertaken above. It should be supported with appropriate graphic and modelling information and allow new information to be added as it becomes available. The report should identify all sub consultants and academic/ industry partners who will be involved and exactly what their role will be. The report should fully justify and cost all future recommended survey, testing, monitoring and sampling to be carried out within the Phase B section of the project
Please note that as Phase A develops and an understanding of the issues increase; there is an expectation that the appointed Lead Consultant should be receptive to engaging with other potential stakeholders/experts if their experience can add value to the project.

Phase B

Phase B will comprise a package of recommendations as reported in A:4, including further investigations, materials testing, sampling and a final report of recommendations and specifications which will result in the preparation detailed recommendations and specifications to address the fabric and environmental issues at the property and inform an appropriate repair and maintenance strategy for the whole property.

A specialist team, led by LDN Architects was appointed in 2016 and began work on the commission. The quinquennial survey was updated; a documentary review was completed; and a programme of initial repairs and investigative work was developed. At this point it became clear that isolated protection of problem areas would not suffice and the NTS committed to constructing the Box enclosure in order to prevent further deterioration of the fabric. Progress on the R&D Project was paused until after the Box was completed.

In late 2020, further discussions took place with the NTS with a view to completing Phase A4 of the R&D Project in the revised context of the Box and the attached A4 Methodology was agreed, describing four steps in the Conservation Planning process:

Stage 1: Baseline Understanding
Stage 2: Factors and Issues
Stage 3: Develop R&D Methodology
Stage 4: R&D Conservation Management Plan

This report collates existing documentary information, describes our current understanding of the issues affecting The Hill House and proposes a route to identifying a preferred Conservation Strategy together with an Initial Implementation Plan for so doing.

"The Mackintosh design is of the highest significance"

4.0

The Hill House

The Hill House

The Hill House is prominently sited on sloping ground at the highest point of Colquhoun Street in Helensburgh, a coastal town on the Firth of Clyde approximately 25 miles north-west of Glasgow. It was designed by Charles Rennie Mackintosh (1868-1928) for the published Walter Blackie (1860-1953) and completed in 1904.

In 1953, after the death of Walter Blackie, it was sold to T Campbell Lawson who subsequently sold it to the Royal Incorporation of Architects in Scotland in 1972 to safeguard its future. The National Trust for Scotland took over ownership in1982 and it remains one of the most important properties in their Collection; open to visitors throughout the year.

The Hill House, together with its boundary walls, gates and outbuildings, was Listed Category A as a building of national importance in 1971. At the same time, the area around it comprising a group of large villas designed by leading architects of the time including M H Baillie Scott and William Leiper, was designated as The Hill House Conservation Area. Historic Environment Scotland's Statement of Special Interest for the property which was last updated in 2018, states that:

The Hill House is the most complete and finest example of domestic architecture by the internationally celebrated architect, Charles Rennie Mackintosh.

The NTS Conservation Statement for the property, prepared in 2011, is included in Appendix I. Its Summary states that:

The Hill House is one of the Trust's most recognisable properties. It stands out in the small portfolio of buildings designed by the world renowned architect Charles Rennie Mackintosh. It is this association that gives the house international significance, the building being a complete expression of Mackintosh's design philosophy of integrating architecture, decoration and furniture. The Hill House offers visitors a unique opportunity to see a Mackintosh building and the style that has become synonymous with him and indeed the Glasgow area.

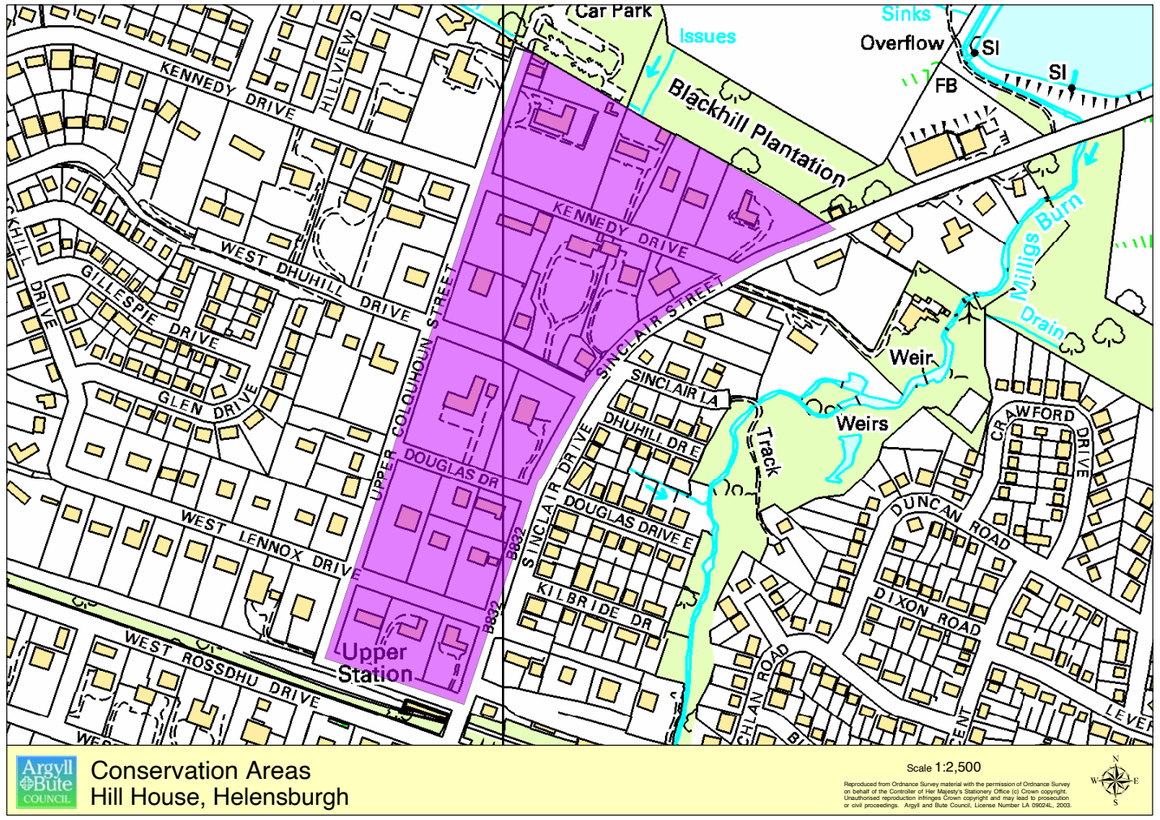
The Statement also summarises the NTS vision for the property:

The Trust will always respect the integrity of the design of the Hill House. As it is the most important element of the house, every effort will be made to conserve the design aesthetic.

The original Building Warrant Drawings for the house exist and although they differ in various respects from what was completed, notably a Billiards Room which was not built, they are an excellent source of information about the original design including types of construction materials used.

The house, as it stands today, looks deceptively unchanged from its original design but close inspection of historical records demonstrates that alteration and rebuilding work has been carried out over the years in attempts to cure the problems of water ingress that have plagued the building. Much of this work has been carried out with the best of intent by leading architects and conservation experts of their time. Internally, the RIAS have also carried out work to convert the East Wing to holiday accommodation and the NTS have made minor alterations to secondary spaces to create visitor and staff facilities. The house remains however substantially as first completed.

A temporary protective Box was erected around The Hill House in 2018 to prevent further water ingress and allow the fabric of the building to dry out. The Box also includes temporary visitor facilities including a shop and café.



The following drawings, images and photographs include:

Building Warrant Construction Drawings dating from 1902

The 1902 building warrant drawings describe the house generally as it was built. The notable omission is the Billiards Room which was not built and some other changes to the external decorative features. The drawings are also helpful in describing the construction materials and where they are used.

Current Plans

These plans are based on documentary evidence sourced to date and have rooms named and numbered as they are referenced by the NTS today. They also show alterations to secondary areas carried out over time.

Concept image and photographs

These images show how the external appearance of the house has changed over time and demonstrate how difficult it is to define what is about The Hill House that is truly *Authentic*.

1903 Concept Perspective
Shows the design as intended but different to as built, including the Billiards Room, subtly different details around the front door, more highly decorative carving around the White Bedroom bay window, and a projecting flat roof over the Drawing Room Bay window. The images also shows the intended entrance approach which is not how most visitors approach the house today.

1905 Bedford Lemere Photo
The house, as built, is similar to the 1903 concept sketch but ornamental details have been simplified and the Billiards Room omitted. The profile of the chimney in the corner between the South elevation and South Gable has been made more slender and a window added to the First Floor fenestration. The Drawing Room bay window roof appears not to project as much as first intended. The profile of the wallheads appear more rounded than in the concept sketch and rainwater drainage has been added. Chimney cans are also visible. The ridge-level corners of the West Gable appear more square as they rise to the roof slope than as intended in the concept sketch where they appear swept.

As has been pointed out by others including Andrew Wright (2012), the Bedford Lemere photos of this time have been taken for a European audience and, although approved by Mackintosh, appear over exposed and make the roughcast elevations look whiter than their reputed original grey colour.

1973 RCAHMS Photos
The colour and character of the house differs from the 1905 photos. Notable changes include the removal of the chimney in the corner between the South elevation and South Gable and the reprofiling of the roof over the wallhead in the same area. Also, the construction of a single storey extension at the front door.

2016
The chimney in the corner between the South elevation and South Gable is back. It was rebuilt in the 1970s and taken down and rebuilt again in the 1980s. Although not obviously changed, documentary evidence confirms that most of the roughcast has been replaced over time and that most wallheads and chimneys have been taken down and reconstructed over the years. This process of change is analysed in more detail elsewhere in this report. The roughcast was painted with a light grey Keim paint in the late 1980s and has subsequently been recoated several times in varying colours.

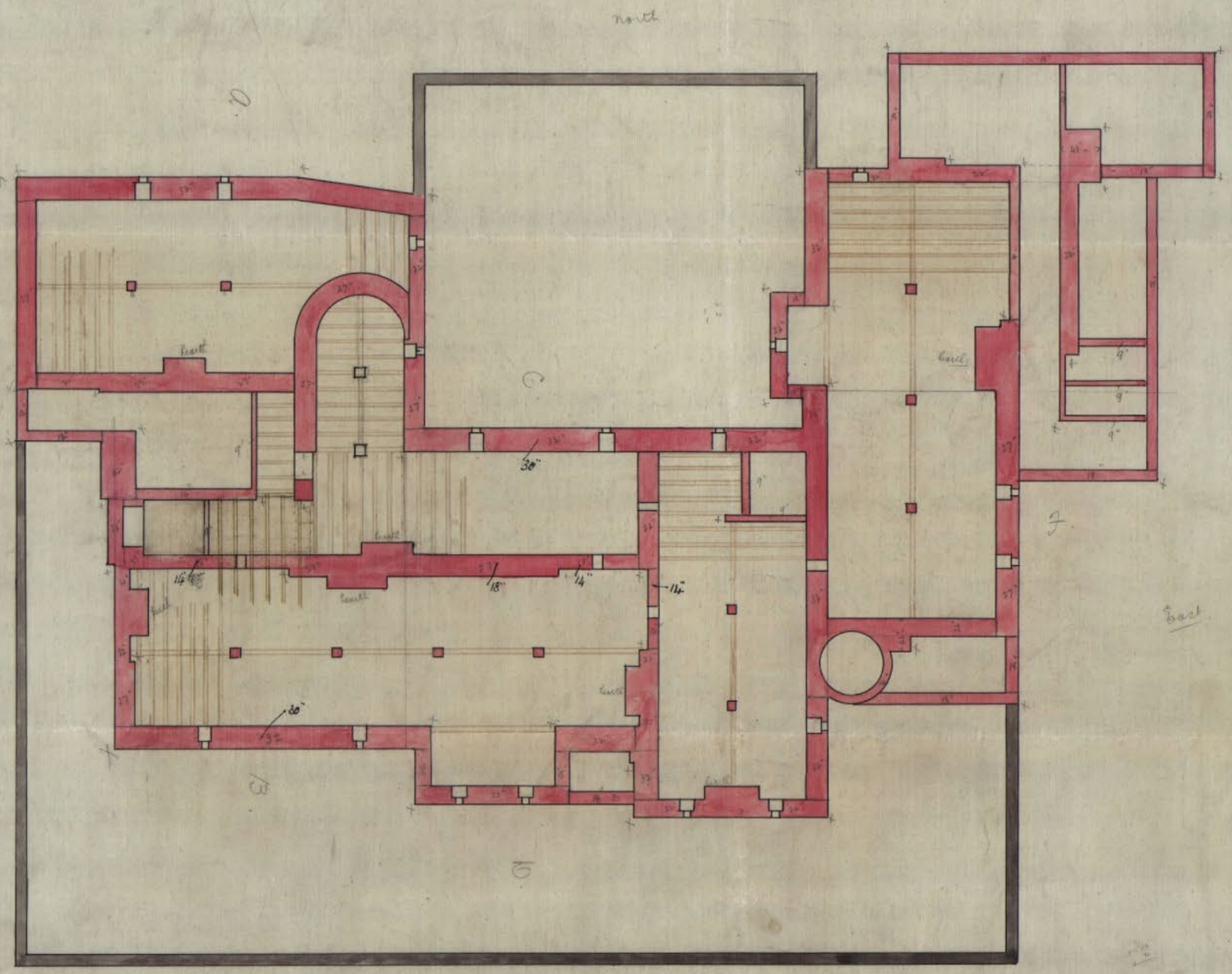
2021
The Box is essential to ensuring the survival of The Hill House and creates a dramatic and unique visitor experience but changes the context and character of the house greatly. It also allows unique vantage points from which to survey the fabric and its changes.

The NTS Vision Statement for the property states that:

The Trust will always respect the integrity of the design of the Hill House. As it is the most important element of the house, every effort will be made to conserve the design aesthetic.

Original fabric is clearly of the highest significance but how significant is the complex story of how the fabric of the house has changed over time compared with the restoration of Mackintosh's original design – whether that is defined as the 1903 concept design or the house as built?

HOUSE AT HELENSBURGH.
FOR W. W. BLACKIE. ESQ.

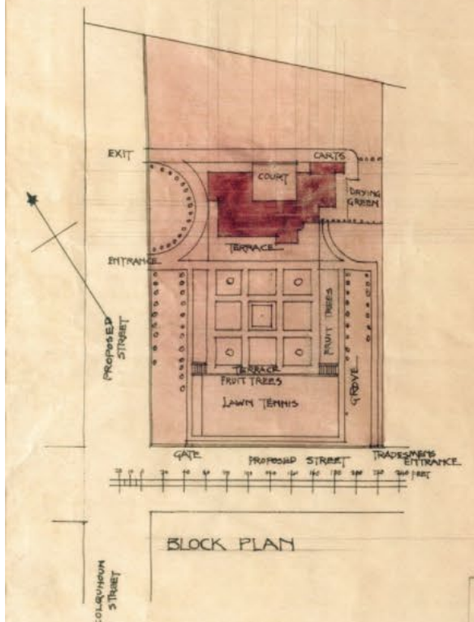


PLAN OF BASEMENT.

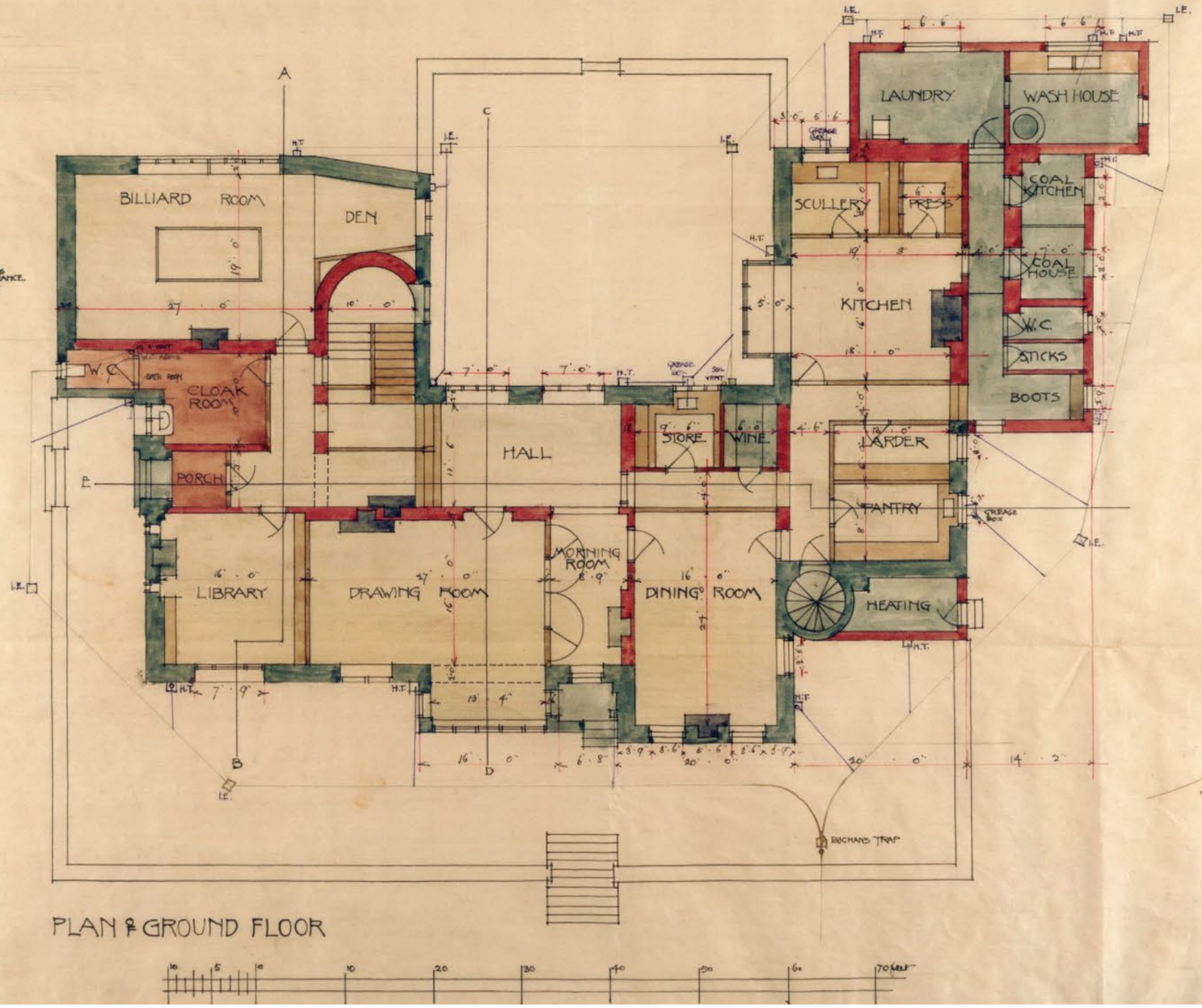
10 5 0 10 20 30 40 50 60 70 FEET.

Honeyman Keppie & Mackintosh
14 BATH STREET.
GLASGOW. MARCH. 1902.

HOUSE AT HELENSBURGH
FOR W. W. BLACKIE Esq.



BLOCK PLAN



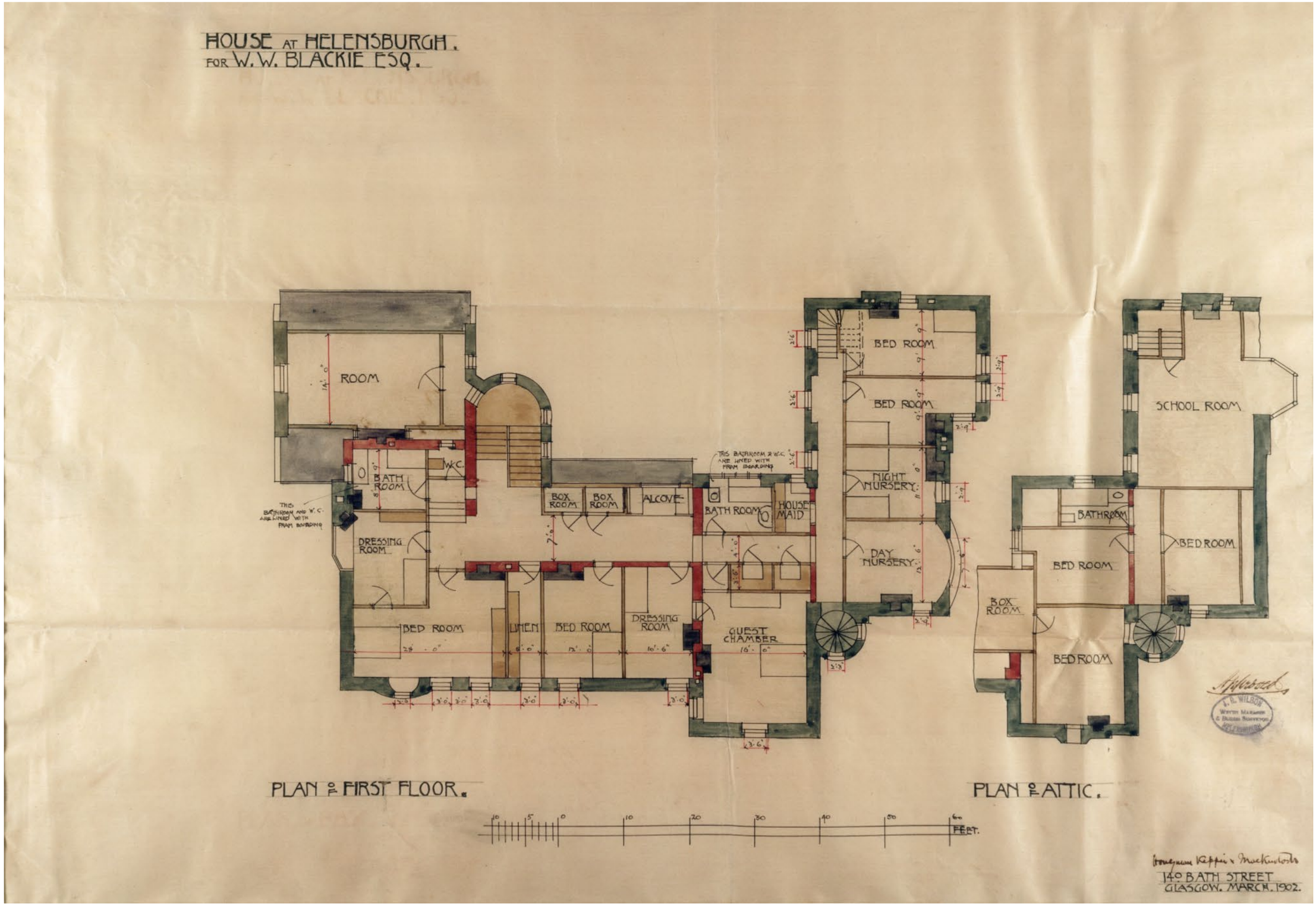
PLAN & GROUND FLOOR

Approved
J. R. WILSON
Burgh Surveyor
& Dean of Guild
HELENSBURGH

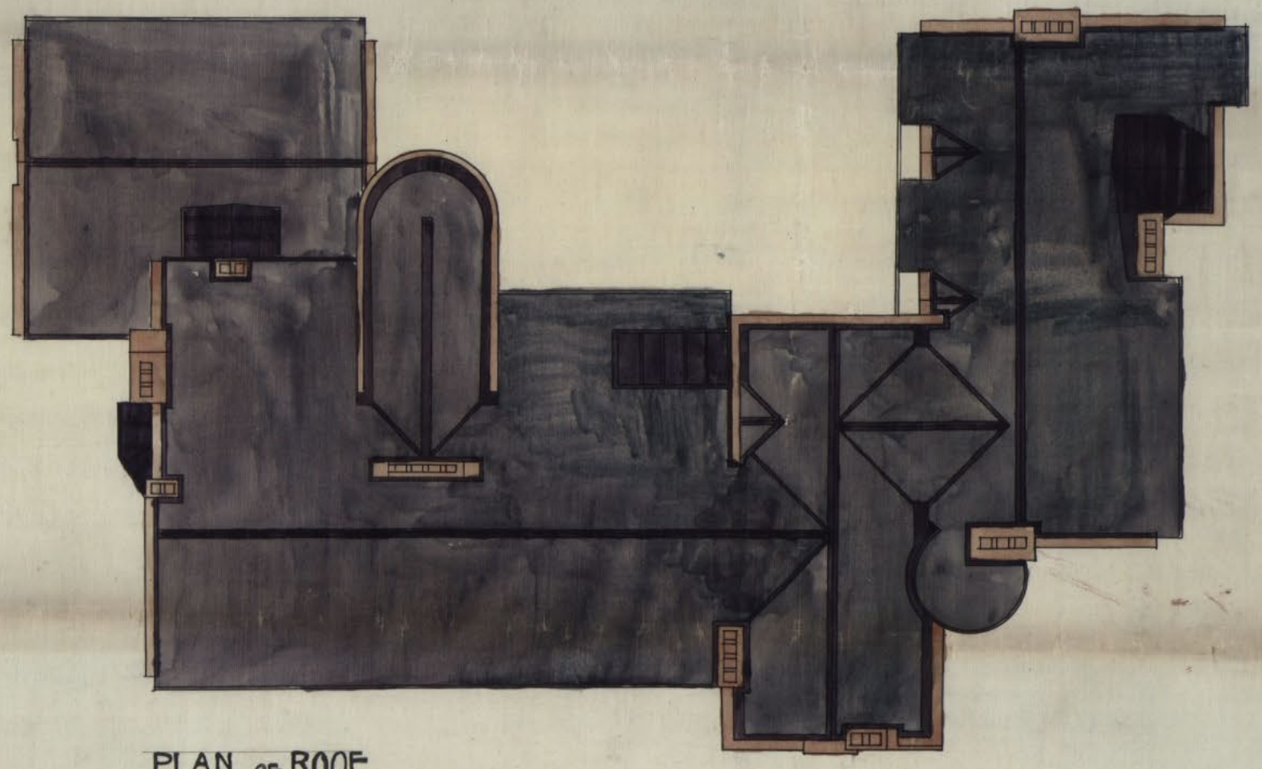
Sam Bryden
Architects
9 June 1903

Honeyman Keppie & Mackintosh
140 BATH STREET
GLASGOW MARCH.

HOUSE AT HELENSBURGH.
FOR W. W. BLACKIE ESQ.



HOUSE AT HELENSBURGH.
FOR W.W.BLACKIE, ESQ.

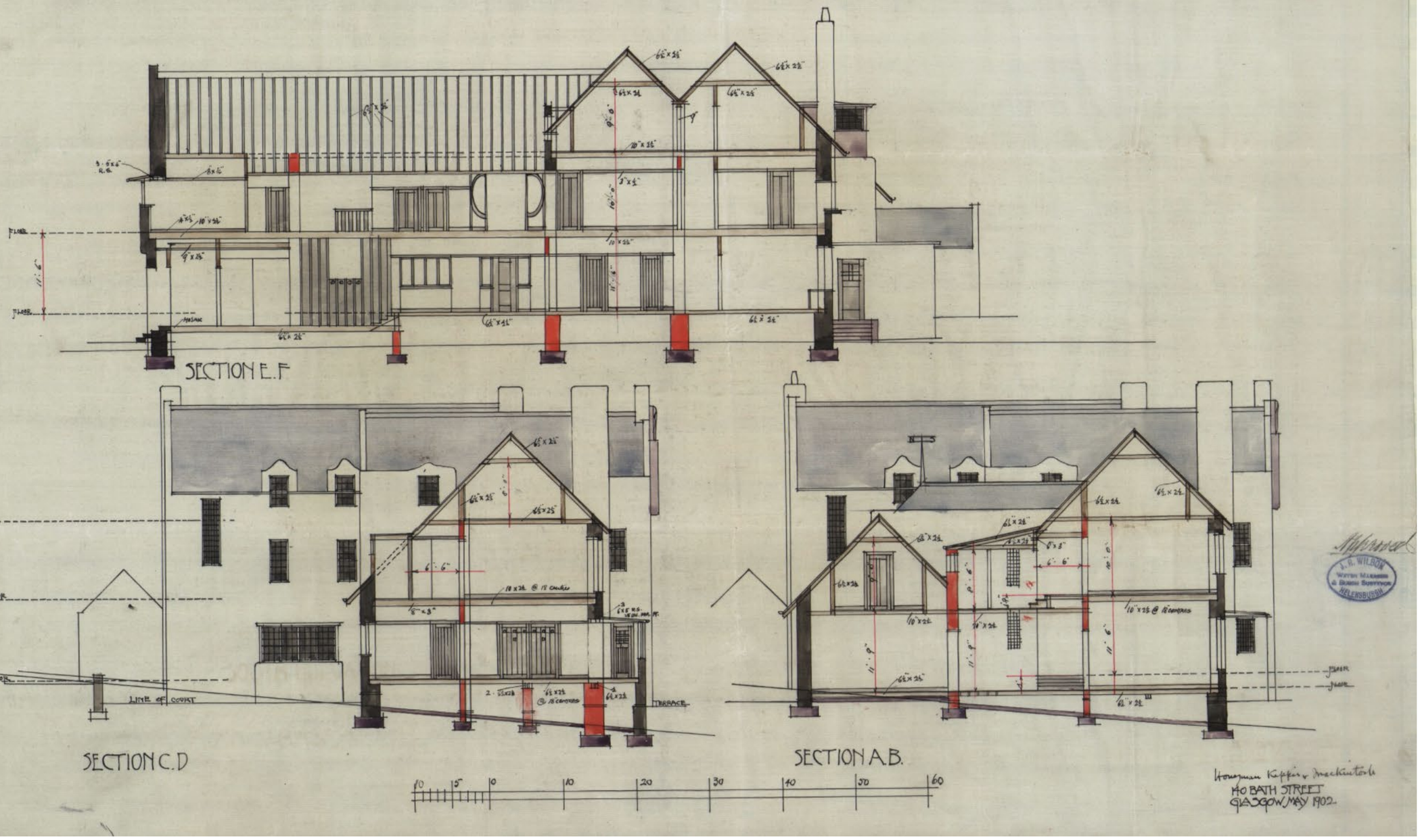


PLAN OF ROOF

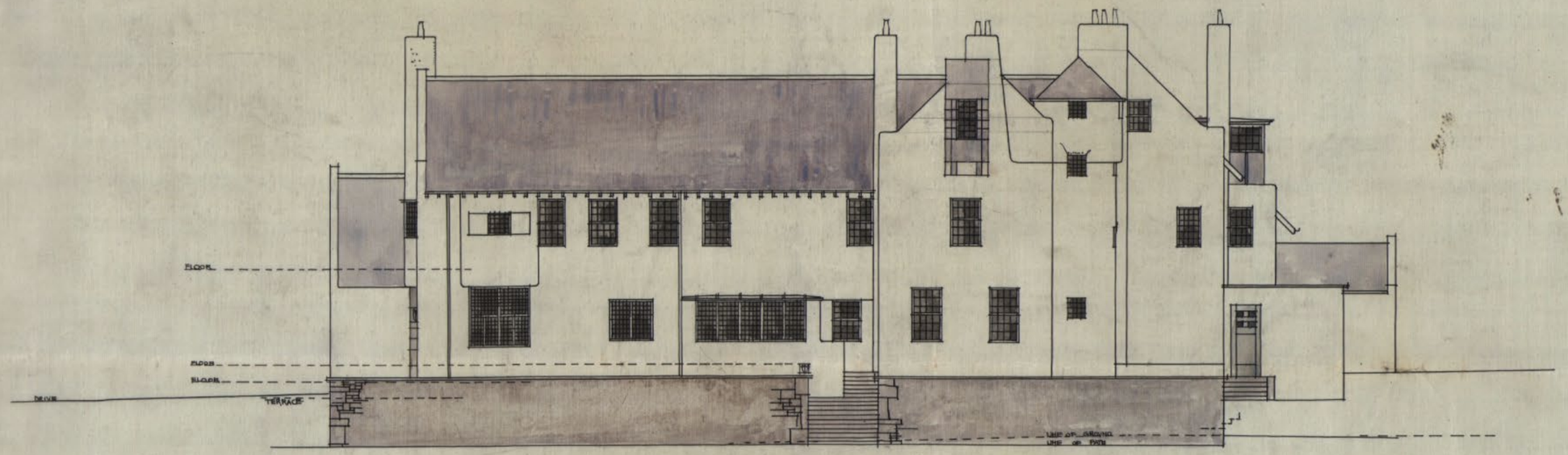
10 5 0 10 20 30 40 50 60 70 80 FEET.

Honeyman Keppie & Mackintosh
14 BATH STREET.
GLASGOW. MARCH. 1902.

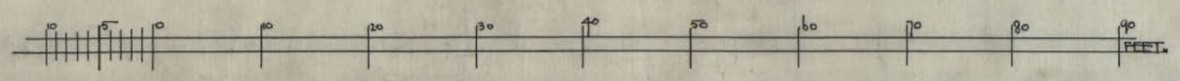
HOUSE AT HELENSBURGH
FOR W.W. BLACKIE ESQ.



HOUSE AT HELENSBURGH.
FOR W.W.BLACKIE.ESQ.



SOUTH ELEVATION.



Honeyman Keppie & Mackintosh.
14 BATH STREET.
GLASGOW. MARCH. 1902.

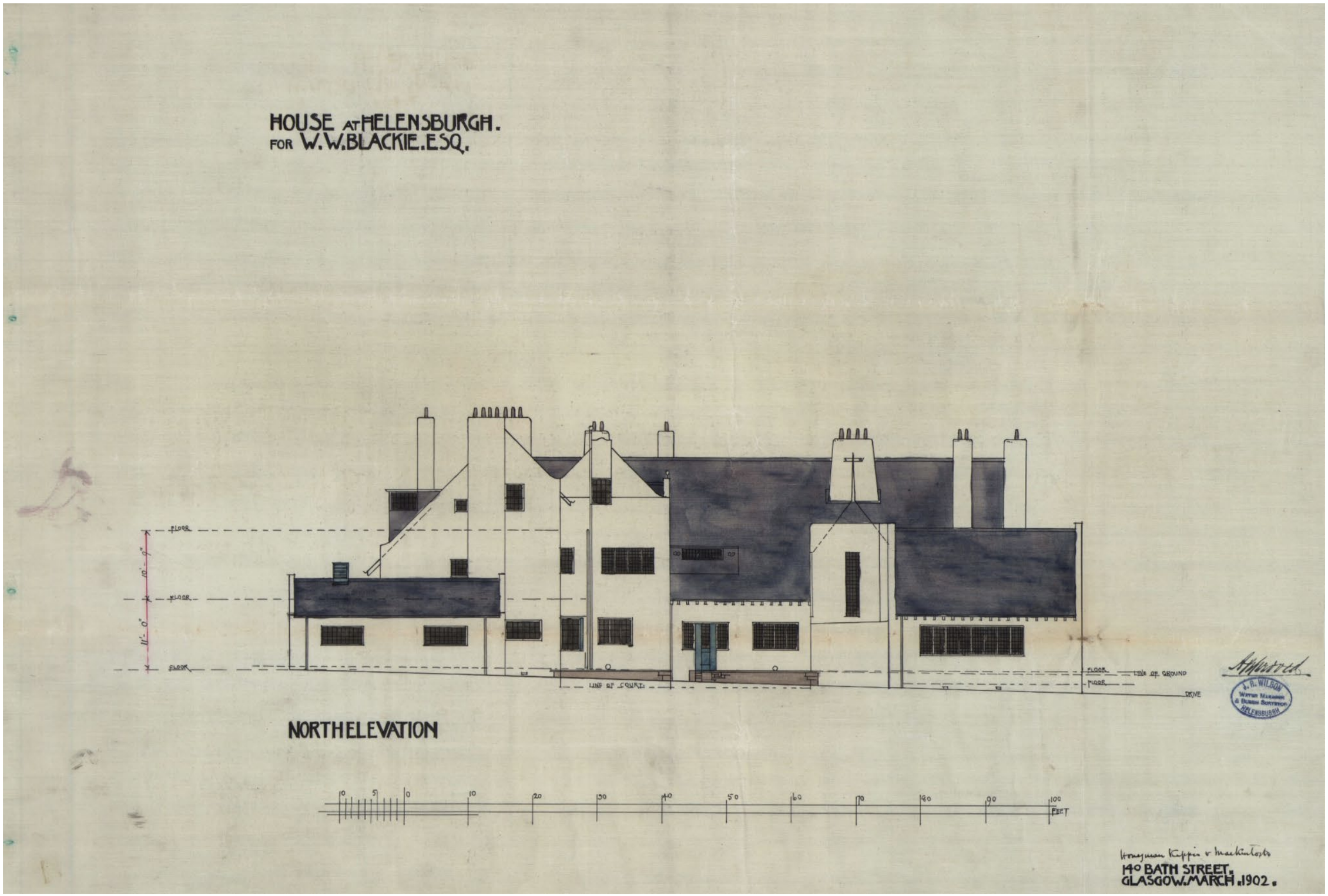
HOUSE AT HELENSBURGH.
FOR W. W. BLACKIE. ESQ.

WEST ELEVATION

EAST ELEVATION

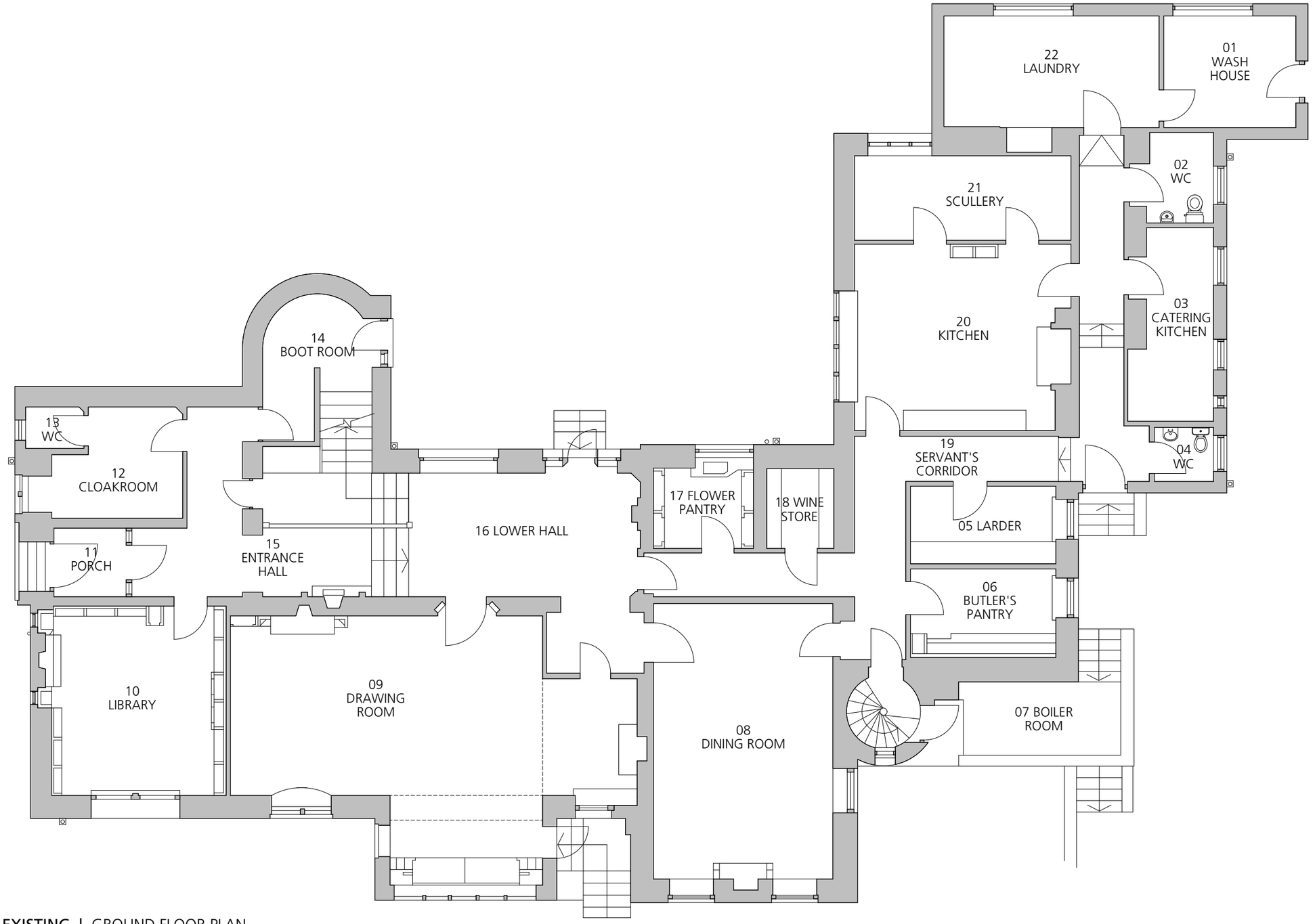
140 BATH STREET
GLASGOW. JULY 1902.

HOUSE AT HELENSBURGH.
FOR W.W.BLACKIE.ESQ.



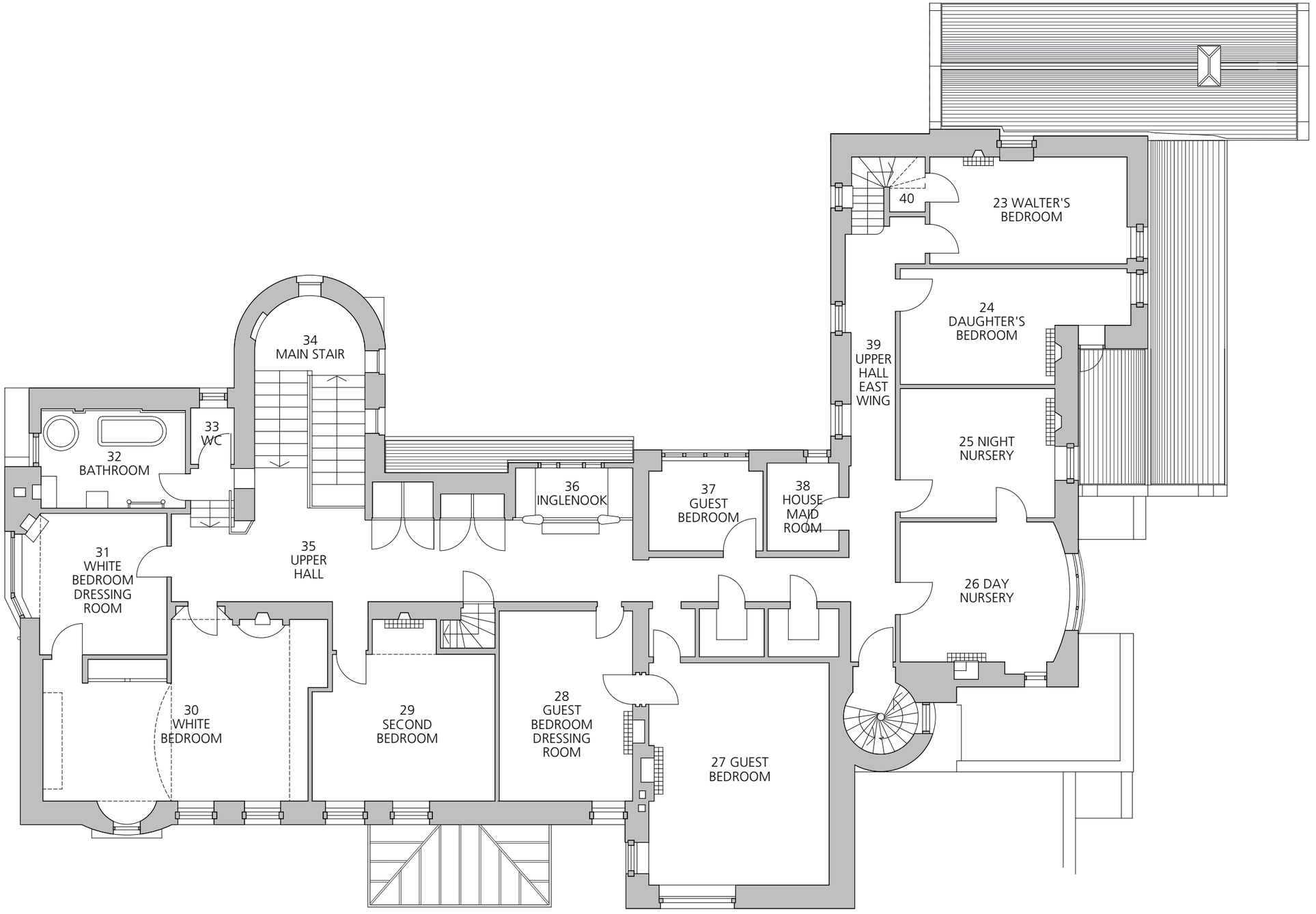
NORTH ELEVATION

Honeyman Keppie & Mackintosh
140 BATH STREET.
GLASGOW. MARCH. 1902.



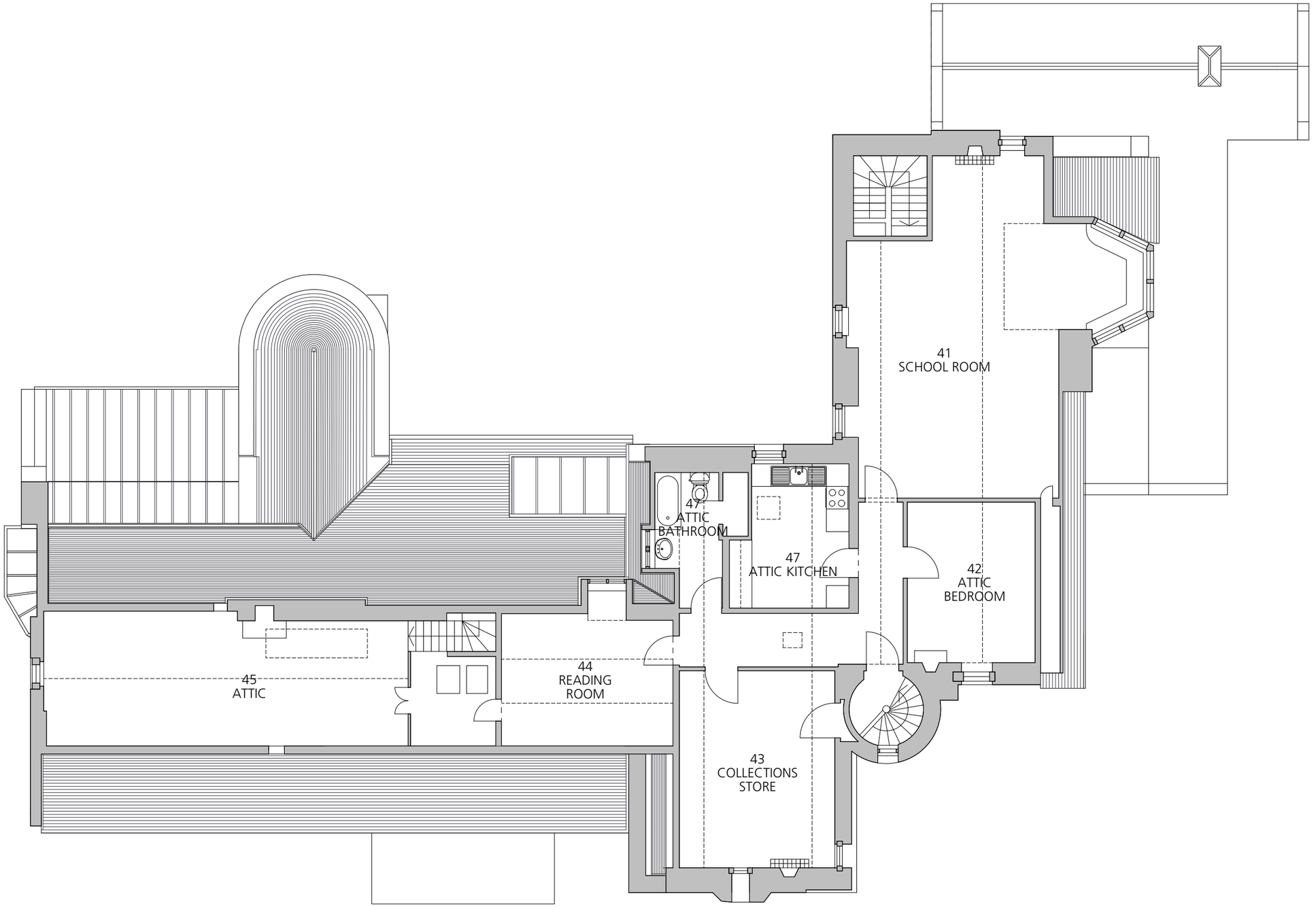
EXISTING | GROUND FLOOR PLAN
1:100 @ A3

LDN Architects



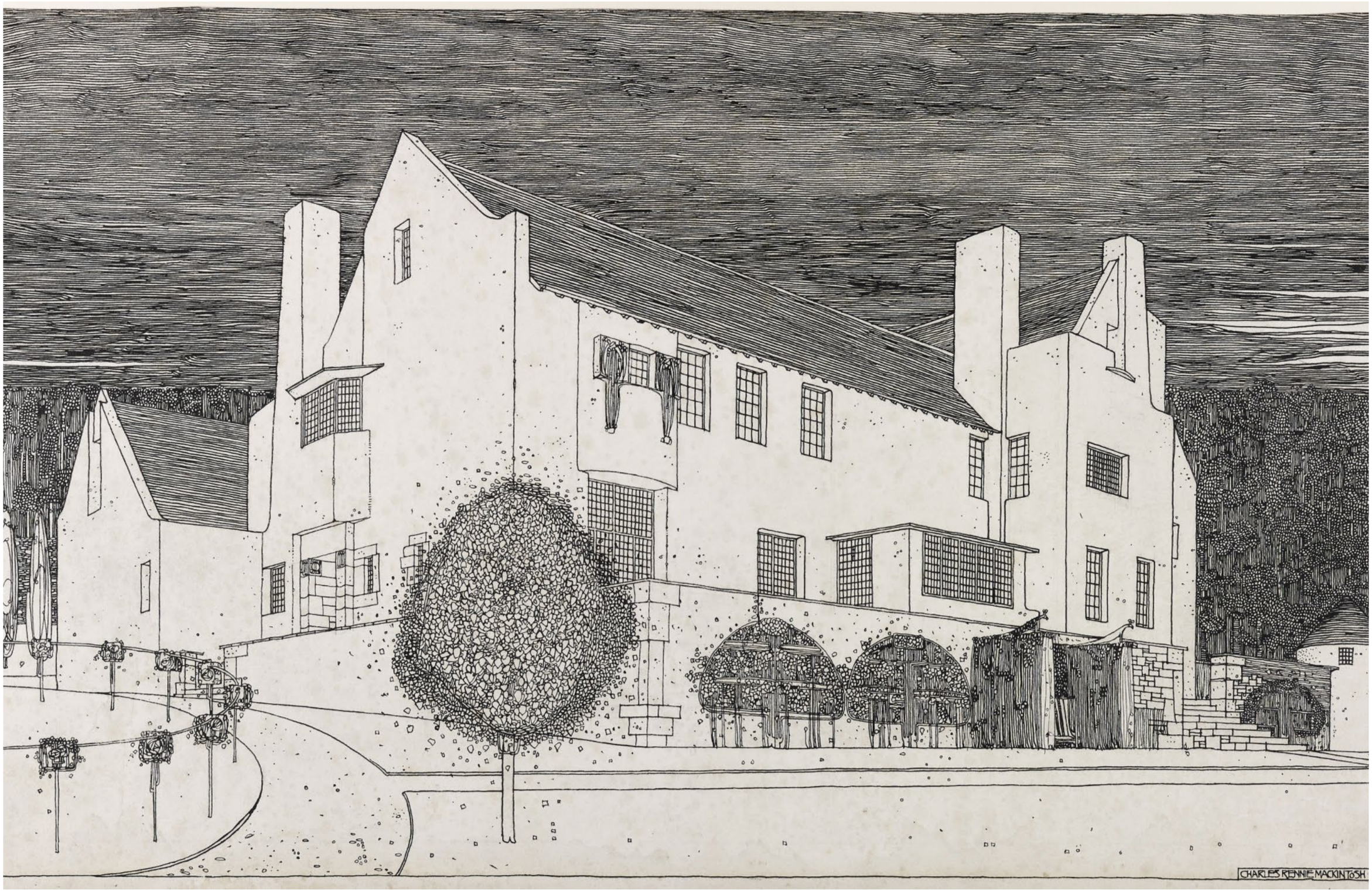
EXISTING | FIRST FLOOR PLAN
1:100 @ A3

LDN Architects



EXISTING | SECOND FLOOR PLAN
1:100 @ A3

LDN Architects



36 *1903 Concept Perspective*

1905 Bedford Lemere

38 *1973 RCAHMS*

1973 RCAHMS

2021 LDN Architects

We were inspired by Mackintosh's residential masterpiece to create a new piece of architecture which protects it from further decay, and gives visitors the chance to experience the house from unique and dramatic points of view.'

Andy Groake, Carmody Groake Architects

5.0

The Box

The Box

By 2016 it was evident from fabric surveys that on-going water ingress through the external fabric of The Hill House was causing severe deterioration of external fabric and placing the condition of the interiors and collections at unacceptable risk. Initially, it was envisaged that temporary weather protection would be fitted over the worst affected areas, including wallheads and chimneys, to halt further water ingress and allow the fabric to begin drying out. The HES thermographic and moisture content surveys demonstrated however that the problems were so widespread that a more radical solution was required. Approaches taken on comparative projects, including Dyrham Park, Knole and Castle Drogo, were researched and in 2018 the award-winning protective "Box", designed by Carmody Groake Architects and funded by many generous donations to the NTS, was completed. It is a dramatic, pragmatic and appropriate temporary response to the problems The Hill House is experiencing which also delivers a unique visitor experience and is an impressive architectural experience in its own right.

The Box, which covers the whole house, is of a galvanised steel-frame construction with semi-transparent stainless steel "chainmail" mesh walls and a solid metal roof. Its mesh walls are intended to protect the fabric of the house from the worst of the wind-driven rain whilst allowing natural ventilation of the fabric to continue. They are also sufficiently transparent to allow the house to be seen still from outside the Box and its surroundings to be seen from the inside the house. Within the Box are a free-standing pavilion with visitor facilities and elevated walkways around the house which allow visitors a unique perspective of Mackintosh's design.

In addition to creating the conditions in which the fabric can dry out, the Box also facilitates access for further surveys and the extensive conservation work that is required. It is intended only however to provide a temporary solution to the problems of water-ingress until a long-term conservation strategy is identified and external fabric conservation work implemented. Its operational life-expectancy is limited both by the materials with which it is constructed, which have limited life, and the fact that the planning consent which covers its construction is for a period of five years only with the possibility of an extension of consent for a further five years, depending on circumstances. It is also evident that the Box is already showing signs of fabric deterioration, including leaks in its roof. A maintenance and repair programme should be developed and implemented.

The evidence of previous attempts to repair the problems of water ingress at The Hill House is that, whilst done with the best of intent and knowledge of their time, they have ultimately failed to cure the problems they were meant to address and have resulted in unintended consequential long-term detrimental impacts on the condition of the fabric of the house. A permanent enclosure around The Hill House may therefore still be required if a conservation strategy which solves the problems of water ingress without further detriment to the fabric cannot be identified and implemented. The existing Box would require alteration and upgrading, if not renewal, to fulfil such a role and the impact of such a structure on the Significance of all aspects of The Hill House would have to be fully considered.

The success of the Box is demonstrated by the evidence of the HES thermographic and moisture content surveys as well as the improvements to the environmental condition of the interiors.

2019

 Ground water pooling along North Elevation, 2021

Elements of the building continue to be saturated in bad weather, depending on wind intensity and direction, 2021

The moisture content of the external walls has reduced considerably and almost all areas have begun to dry out beneficially. There is evidence however that the rate of change is causing some damage to interior finishes and the rate of drying out and its impact on the interiors should be monitored and potentially managed.

The Box prevents most wind-driven rain from hitting the house but it is evident in bad weather that exposed elements of the house continue to become wet, depending on prevailing wind direction. The lack of rain on most surfaces however does mean that exposed roof surfaces, horizontal ledges, and cracks in the roughcast are becoming dirty due to an accumulation of air-borne dust and that organic growths are appearing. There is also some evidence that the external fabric of the house may be becoming too dry and this needs to be monitored. Periodic water-washing of the house should be considered.

The Box also prevents rain from entering the building directly through open chimney flues and the removal of chimney caps and re-opening of chimney flues should be considered to improve ventilation of the fabric and therefore it's drying out. Given the beneficial environment the Box creates, consideration should also be given to removing further non-original roughcast in order to assist drying out and further fabric survey work.

Whilst the Box delivers a number of conservation benefits, one drawback is that it prevents the preparation and monitoring of trial conservation repairs and materials in situ. Alternative methods of so doing will have to be developed.

The impact of the Box is mostly above ground but there are also hidden impacts. The construction of the foundations and sub-structure of the Box has affected the original status quo around the site, in particular the below-ground drainage system that served The Hill House.

The foundations of the Box comprise large reinforced-concrete pads founded at depth on suitable load-bearing strata. The size and extent of the foundations is significant and on the north and south sides of The Hill house in particular, the large pads are placed very close together. Indeed, there is a possibility that they were actually formed within a single trench, effectively creating a wide, deep, strip foundation; this needs to be checked with the project team who constructed the Box.

The Box is also served by a new below-ground drainage system. This system was originally designed and intended to be independent of the existing system which served The Hill House but is now linked with it. The new drainage system comprises separate foul- and surface-water systems within the site that connect to the existing main public sewer below Upper Colquhorn Street.

The new private foul-water system is connected directly to the public sewer.

The surface-water system carries discharge from the rainwater goods serving the roof of the Box. In addition, the surface-water system carries discharge from a land-drain set below the perimeter of The Box. The purpose of this land drain is to catch rainwater falling down and from the sides of The Box. This drain is considered to be a sensible precaution given that the land and hardstanding about The Box was wholly irrelevant to it, potentially giving rise to localised flooding.

The surface-water system is connected directly to the public sewer via an attenuation tank and flow-limiting device whose combined purpose is to limit the flowrate into the sewer (thereby avoiding the risk of it being overwhelmed at times of peak flow) whilst providing storage capacity within the site for any restrained flow.

The long-term damp issues within The Hill House are suspected to be caused at least in part by high levels of ground water about the site. To address this, a long-term proposal is to install a shallow land drain about the perimeter of The Hill House whose purpose would be to intercept and direct away any groundwater at or near foundation level of the building. The Site Investigation carried out to inform the design of the foundations to the Box concluded that groundwater levels could be encountered at high levels within the ground, close to the building. A land drain was constructed as part of The Box works, but to a different design than originally intended to meet the long-term needs of the site.

The foundations and sub-structure to the Box clashed with parts of the existing drainage system serving The Hill House. Where these parts of the existing system needed to remain live because they were serving toilets and other welfare facilities about the building (i.e. carried foul-water (FW) flow), the existing drainage was altered accordingly such that it could remain operable.

Other affected parts of the existing drainage system serving rainwater goods only were capped off and considered to be redundant owing to the protective role of the Box.

Surveys of the existing drainage system revealed parts of it to be in poor condition, requiring repair. Where these parts would be rendered redundant by the presence of the Box, because they served rainwater goods only or drained external surfaces immediately about the building, they were capped off and left inoperable. The exception to this is pipework handling foul-water flow which was repaired and connected to the main system as described above.

Drawing 17.1108-01D shows the existing drainage serving the site as it was finally determined to be following numerous surveys. Drawing 17.1108-07F shows the layout as it was intended to be after completion of The Box.

The land drain proposed about the perimeter of The Hill House had to be coordinated with the foundations and substructure of the Box. For it to be of use, the drain was placed outwith the line of foundations.

Perforated pipework along the north side of the Box is intended to catch ground water flowing down hill from the top of the site. Solid pipework down the east and west sides of the Box connect to an existing cundy passing through the site.

The invert level of the perforated pipework along the north side of the Box is set to match that of the base of the solum of The Hill House; owing to the rising topography of the ground to the north side of the building this meant the pipe being at a depth of about 1.8m, being around about formation level of the foundations of the Box.

6.0

Construction

1903

1903

Construction

The Hill House was built at the start of the 20th century during a transitional period when traditional craft materials and processes were used alongside new industrial products to create contemporary designs. Its external fabric combines traditional and new materials which are described below:

Stone

The stone used for the wall construction of The Hill House is a deep red / orange split boulder rubble sandstone which was not intended to be visible in the completed building. It is understood to be locally sourced although the actual source of the material has not yet been established. The CMC Materials Report (2012) comments that it is typical of Permian Sandstones of the Eden Valley (Cumbria) and from quarries that worked Old Red Sandstone found in the Helensburgh and Balloch areas. Wright (2012) notes several other possible sources for this stone including Bonhill in Dunbartonshire, Corrie on Arran and also Skelmorlie in North Ayrshire. The stone, due to its composition, is susceptible to delamination and deterioration if exposed to periods of prolonged saturation. The exposed and salty environment of The Hill House's coastal site exacerbates its deterioration.

There is evidence that the stone was laid on cant (face-bedded) and that its face was tooled to provide a rougher surface and better bond for the roughcast. Whether the face-bedding of the stone was intentional and had been instructed by Mackintosh, or was a decision by the builder, is unknown but it is certainly not good practice as face-bedded stone can delaminate badly as a result of being loading-bearing in the wrong direction, saturation and failure of its surface bonded with the roughcast. Wright (2012) notes that perhaps the architect and his builder were so convinced with the promised performance of the cement-based roughcast that the quality of the substrate was not really a factor to be concerned with.

The CMC Materials Analysis Report (2012) describes the stone as follows:

The stone has a high porosity, with pores common and well connected throughout the thickness of the stone, but more so in the coarser laminae. The open porosity was measured at 19.3% with a total porosity in the region of 22.5%. This along with an apparent density of 2150kg/m3 and water absorption of 8.2% would again suggest that this stone would not be well suited to locations where it would be maintained at high levels of saturation over extended periods of time, particularly if also exposed to percolating waters. This was confirmed by the low strength determined on the sample, which gave values of 13.6 to 19.2N/mm2 in the dry condition, with this falling by 30 to 40% when saturated, i.e. 7.9 to 13.8N/mm2.

On the basis of the properties determined on the sandstone sample examined, it is concluded that this stone will be susceptible to failure, due to delamination, particularly where face bedded, but also susceptible to scaling, where naturally bedded, if exposed to percolating waters, over an extended period. It would, therefore, be necessary to provide additional support, such as a lath, to any strong cementitious render applied to walls constructed from this sandstone, if long term durability is required.

An ashlar finished honey-coloured sandstone is exposed as a decorative feature in a few areas to emphasize the front door and celebrate selected window openings.

Brick

The original Building Warrant drawings show that, as well as sandstone, common brick was used extensively in the construction of the house. The reasons for this mix of materials are unknown but it is possible it was due to cost; perhaps availability of materials; and certainly ease of construction at complicated areas of construction. Brick also appears to have been used where a thinner wall construction was required including the construction of the East service Wing and for all chimneys.

Bullnose bricks were used at gable skews and parapet walls at the north-east of the House and main stair tower. These allowed the render to be cast up and over the top of the parapets and gable skews without a sharp edge. Brick was also used below ground in the solum and for the brick piers to support the floor construction.

The CMC Materials Analysis Report (2012) states that the brick composition may also be a source of some of the problems being experienced:

On the basis of the mineralogical and chemical analysis carried out on the brick it is indicated that the brick is a potential source of some of the components found in the salts forming the efflorescence observed on the sandstone dressings, and found in the dust below the floor. These were a combination of alkali carbonate and alkali sulphate based salts, i.e. Mirabilite, Thenardite and Natron, with the brick indicated to be a source of alkali, with both sodium and potassium present in the samples analysed.

The presence of the soft white inclusions detected in a sample, and the abundance of calcite (Calcium Carbonate) also found would suggest that the calcium content of the brick is locally high, with the potential for the formation of Lime (CaO) within the brick during manufacture. If this were the case, the lime could slake, in place, as the brick wetted, by percolating waters, with the expansion resulting from the slaking of the lime, possibly sufficient, to result in disruption of individual brick, and if a sufficient brick of this type existed in the walling, in the disruption of areas of wall fabric.

Over the years, many repairs have been carried out in a variety of other common and engineering bricks. These include wallhead repairs, the refacing of walls, and the reconstruction of chimneys. The full extent of these repairs and their impact on original fabric is currently unknown due to the repairs being hidden by the existing roughcast.

Roughcast

The external walls of the Hill House are coated with a thick layer of Portland cement roughcast finished with a Portland cement wash, modern materials of the time.

Mackintosh's attitude to modern industrial materials was to use them truthfully, in line with Arts and Crafts principles, subverted at times by the introduction of craftsmanship and ornamentation. At The Hill House this use of modern materials is exemplified by the use of Portland cement. A leading and celebrated Scottish plasterer at the time, William Millar, wrote that Portland cement was 'unrivalled for external plastering. Its strength, tenacity and adhesive power give support to a wall, instead of a dead weight having to be carried…No other material, whether used monolithically or as a casing for stone and brick work, will resist the action of our variable climate like Portland cement.' (Wright, 2012, p 24.)

The promise of damp-resistance and high performance, promoted by the building industry at the time, possibly led Mackintosh to believe it was a product that would keep water out of the building and therefore remove the need for traditional weathering details such as wallhead coping stones and drip details on the edge of cills and other ledges. His confidence in the use of Portland cement in this way is reflected by the omission of traditional weathering details at The Hill House when compared with his earlier projects including the Glasgow School of Art and Windyhill. The problems described elsewhere in this report demonstrate however that his confidence was misplaced.

The CMC Materials Analysis Report (2012) describes the original roughcast as follows:

From the analysis and petrographic examination of the render it is confirmed that the two inner coats in the render are from the same mortar, and that the cement used is a Portland type, with the clinker much coarser ground than modern day cements.

The mix used in the render was found, on chemical analysis, to consist of 1 part cement to 0.3 parts lime to 2.7 parts aggregate, and to range from 1: part binder (cement + lime) to 1.5 to 2.0 part aggregate, on the basis of the modal analysis. This is considerably richer than the mixes used currently, but this would have been consistent with mixes made employing hydraulic lime binders, at the time of construction, when cement was starting to displace lime as the binder of choice, but where similar mix compositions were employed. The rich mix also accounts for the high strength measured on the render, which was found to be in the region of 20N/mm2.

The high strength, binder rich mix and the coarseness of the cement clinker all combine to make it difficult to replicate the "original" mortar, should that be considered necessary, without introducing both a support strong enough the withstand shrinkage forces that would accompany such a 'modern' mix. In addition, it would be necessary to introduction of a number of movement joints to accommodate shrinkage and thermal movement in the replacement mortar.

The render is finished with a wet dash, which had been coated with a cement wash. The aggregates are consistent with the dash aggregate reportedly being sourced from Arran Granite, with a nominal particle size of 4.0mm. The dash aggregate is bonded within a thin sand/cement slurry coat. It was also noted in further samples that two coats of dash aggregate had been applied, with the outer coat having a higher cement content than the inner, possibly incorporating a surface cement wash, applied at the same time.

Examination of additional samples of render, again obtained from the ceiling void above the toilets to the Tearoom on the East elevation, indicated that there was up to four coatings applied to the Render. Two coats of Harl, applied as a "Wet Dash", followed by a white filled coating, based on a hydraulic lime binder, which was then recoated, within a short time period, with a further grey Portland cement wash.

There was no evidence of soiling at any of the interfaces between the coatings, suggesting that the white coating must have been placed early in the life of the building, but this again was covered within a relatively short period of time. The white coating was found on analysis to be a very fine sand filled hydraulic lime based material, containing a white pigment. The white coating was again covered with a grey Portland cement wash, which was made from neat cement, with no aggregate of filler incorporated. The recoating apparently occurring before the white coating had become weathered or soiled.

Within the solum of the house there are deposits of decomposed stone and brick. The CMC Report (2012) states that:

Dust & Debris at Base of Walls

It was shown from the analysis of the dust and debris accumulating at the base of the walls, internally at wall DPC level, that the arisings were accumulation of material lost from the inner face of the sandstone. This was confirmed by comparing the mineralogy of the arisings with that from the sandstone sample.

The only difference between the composition of the sandstone and the dust was that the dust contained a high proportion of Gypsum along with Bassanite and Sodium Chloride.

The sulphates and chloride being present as contaminants and reaction products, both of which could be responsible for the breakdown of the sandstone, in response to expansive crystal growths within the near surface pores and within the weaker laminations within the sandstone.

The source of the sodium chloride is likely to be from wind transported sea spray and possibly some contamination from de-icing salts used on the footpaths and adjacent roads. The sulphates could be leached from the brick used in the walls and chimneys, leached from flues, accumulated from soot deposits and acid rain and also possibly leached from gypsum plasters, if present on the wall coverings internally.

Although there is a high salt (chloride and sulphate) content in the dust, there was none in the sandstone sample analysed. There was also no evidence of sulphate related fabric deterioration in the render sample examined. However, this may be due to the render examined having been taken from a sheltered and protected area of wall which was found to be placed against dry brickwork.

Salts

Salts were found in the dust sampled from the base of the walls, internally at DPC level, and also on the surface of brick, internally below DPC level and the solum was found locally to be covered in almost pure gypsum.

In addition, salts were found to be present on the surface of the sandstone dressings to the main entrance doorway. Visually similar forms of salt were also observed on sandstone dressings to windows on the West elevation, and locally elsewhere, but to a much lesser extent.

No evidence of salt deposits was observed on the render sample examined, but no samples of render from exposed locations have been analysed to date.

The main salts found below floor level have been dominated by gypsum, in both hydrate and hemihydrates forms, with this most likely a function of the leaching and mobilisation of soluble salts and its reaction with free lime, either from the cement or lime plaster used in the lath and plaster on internal walls. However, the high concentration found covering the solum, below the Lounge and the library is such as to infer that it had either been placed on the solum as a surface covering, or the solum had become heavily contaminated with plaster during the internal finishing works.
Irrespective of its source there is evidence to suggest that it is migrating into and up the brickwork perimeter walls in capillary water rising from ground water.

The salts at the main entrance are composed of a complex range of alkali carbonate and alkali sulphate based salts, along with sodium chloride.
The alkali may originate from the cement in the harling, but may also be originating from the brickwork of the chimney above. The sulphate may again originate from the brick, or be leached from the flues above, with the carbonate from the cement, or any lime based mortars or plasters, and again possibly the brick. There is also the possibility that some of the components may have been incorporated within any past surface treatments, or have been mobilised in response to such treatments.
The sodium chloride is again probably present both from wind transported marine salts along with a proportion from de-icing salts.

The abundance of the salts now apparent on dressing on the West Elevation, however, is considered to be a function of the degree of saturation to which this gable has been exposed. With data from infrared thermography surveys and visual inspections confirming that the lower level of the wall on this elevation is affected by both draining moisture from the chimney and wall head above along with wind driven penetrating waters.

Windows (Timber and Metal)

Mackintosh specified a number of different types of window to create the aesthetic he required. He utilised new materials, technologies and off-the-shelf products in a ‘craftsman-like way’. In his essay on Mackintosh and Materials, MacInnes notes that Mackintosh used a highly unusual pivoting sash and case window of a type advanced by the National Accident Prevention Window Company. Each sash could be pulled forward free of the frame and in the closed position they could be used like a normal sash and case. The windows could be opened for ventilation without the risk of falling. He also specified ‘Hope’s’ metal windows which were standard products from a catalogue. (Henry Hope & Sons Ltd in the West Midlands were founded in 1818 and supplied metal components including metal windows, roofing, gearing and decorative metal ironmongery across the UK and the world). Each window has squared paned glass and there is a mix of lead kames and timber glazing bars to both metal and timber framing.

In his ‘Evaluation of Condition and Significance’ Report, Wright notes that ‘although they may be unconventional in design, they are capable of being repaired by orthodox conservation techniques without causing major intervention or the replacement of original material.’

Not only was the seemingly illogical positioning on the elevation of the windows critical to Mackintosh’s design (a ‘restless composition that borders on Mannerism’ – AK Wright) but also the depth at which the windows were positioned in the reveal. These ‘experiments’ in Mackintosh’s ‘quest for minimalism’ created a unique aesthetic but caused problems later on in terms of water ingress and a further conservation challenge in the decisions to keep Mackintosh’s design integrity whilst trying to improve on flawed detailing.

A 2009 report on the glass in the Gardener’s Cottage (Appendix H) notes that windows consist of clear glass set into metal or wood frames and references a 1997 Conservation Record of conservation work carried out by the Stained Glass Partnership during the 1990s.

Roof coverings (Slate and Lead)

The roof coverings were originally Ballachulish slate, a West Highland slate, laid in diminishing courses. It was rough and blue-grey in colour. From an early elevation drawing Mackintosh had originally thought to use 'Aberfoyle Grey' and so the change to Ballachulish was likely an aesthetic decision and not a cost saving as it was the more expensive option.

Philip Schreiber notes in his 1998 Quinquennial report that the roofs are of 'West Highland slates, a mix of original Luss slates and second-hand West Highland from 1985 re-roofing project.' However, we know the original slate to be Ballachulish. Luss slates may have been introduced in later repairs and alterations to the roof profiles. (See QQ Reports 1998, 2012, 2016)

The roofs were completely re-slated on new underfelt with new concrete ridging by Boys Jarvis in the 1983-1986 works. Defective slates were replaced with new West Highland slate (exact type unknown) and reclaimed WH slate from the roof. Minutes of a meeting on 22 February 1983 recorded that insulation had been proposed and that it was possible to retain 50% of the existing slates. A cost estimate a year later allowed for 60% new slates, new concrete ridging and new underfelt.

There are several areas of lead roofing including the projecting bay to the Dining Room on the south elevation, the small roof over the bay window at first floor on the west elevation, the lead of the dormer windows overlooking the north courtyard and the roof of the angled bay at the old School Room/Landmark Trust flat on the east elevation. Lead was installed at the cill / wallhead of the east bay window where it had not been before. It is assumed that most if not all of the leadwork was replaced in the 1983-1986 reroofing works including the flat roofs, valleys and flashings. Weather-proofing details were upgraded and it is possible that a heavier gauge of lead used.

Rainwater Goods/Soil/Vent Pipes

Whilst the location and layout of the rainwater goods, soil and vent pipes have remained generally the same, all but one have been replaced with painted aluminium. Only one downpipe at the east elevation remains, which is original and of cast iron.

Repairs

The Hill House has been plagued by problems of water penetration for much of its life caused mainly by technical aspects of Mackintosh's design, which lacks traditional weathering details, and his use of Portland cement roughcast which has cracked, delaminated and failed in many areas.

Numerous attempts over the life of the house have been made to cure the problems. These repairs range from wholesale replacement to conservation and consolidation, reflecting the best conservation knowledge and principles of their time, and most have resulted in temporary success. Problems have always returned however with the risk of further collateral damage. In some instances, the repairs have replaced original fabric with new and in others the repair processes and materials may have caused significantly more damage than the problems they were intended to solve.

Various attempts have been made to identify the extent of repairs and the materials and techniques used, notably Schreiber (1995), and our current understanding is summarised elsewhere in this report. There are knowledge gaps however and further survey work is required to establish exactly how much original roughcast actually remains and the current condition of underlying original stone and brickwork.

In summary, there have been four differing approaches to solving the problems of water ingress through the external fabric:

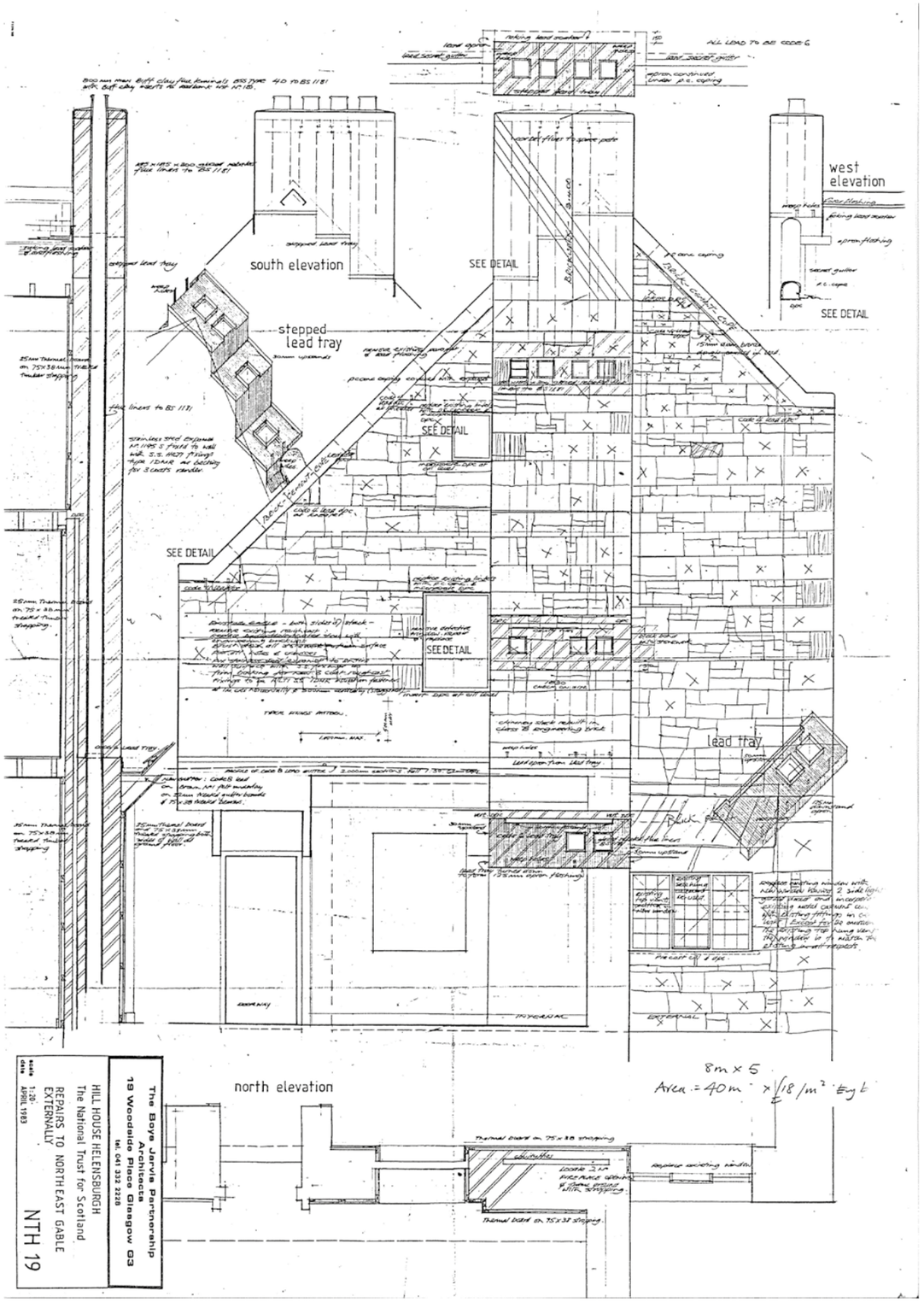
1950s Repairs by Margaret Brodie for Campbell Lawson
Margaret Brodie was a leading architect of her time but is reputed not to have had a high regard for Mackintosh's work and felt free to adapt the form of the building. Mackintosh's weathering details were altered to more traditional forms and problem elements of the building were removed to solve the problems. These included the removal of the main chimney at the corner of the tower and south elevation and the realignment of the roof.

1970s Repairs by Gillespie Kidd & Coia for the RIAS
As leading modern-movement architects of their time, it should perhaps not be a surprise that they were commissioned to repair and alter The Hill House. With hindsight however and an appreciation of the problems that have affected their own buildings through the use of 20th century materials and technologies, they might not have been considered as best placed to do so today. Their work on the exterior of the building included repairing roughcast and focussed on restoring Mackintosh's design by reversing the alterations carried out by Margaret Brodie including reconstruction of the chimney she removed.

1980s Repairs by Boys Jarvis for the NTS
Repairs by Boys Jarvis were much more interventionist. They replaced areas of roughcast and "cloured back" underlying defective stone and brickwork to sound surfaces prior to rebuilding in new brickwork. Roughcast was also injected with polyester resin to waterproof it.

1990s Repairs by Page & Park architects for the NTS
The architect Brian Park's 1992 article Cracking up: Hill House', in the Architects Journal describes the conservation techniques used to repair the roughcast at that time. The focus, which was the subject of much debate, was to retain as much existing fabric as possible. Areas of delaminated roughcast were therefore pinned back to the underlying substrate with dowels and silanes used to waterproof the roughcast.

The conservation and repair work of the time was comprehensive and further research into Page and Park Architect's surviving records would help ascertain the full extent of their research, the extent of conservation work carried out and the techniques used.



Boys Jarvis North gable repairs 1982. Note gables of laundry covered by slates. cf images p46

Investigating North Gable. Boys Jarvis 1983. (Ingual Maxwell of Historic Scotland in photo?)

The following elevation analysis drawings are based on documentary evidence uncovered to date and describe the type and extent of underlying wall materials.

KEY

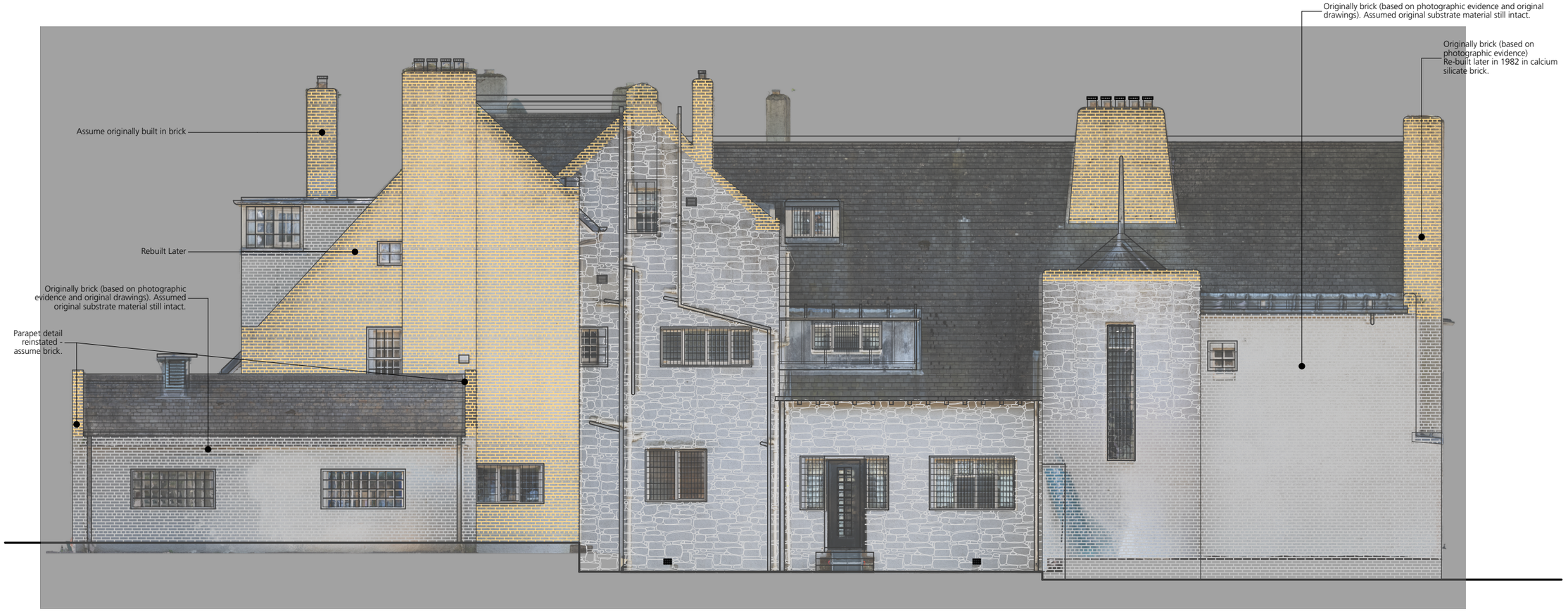
- Original brickwork substrate
- Original sandstone substrate
- New brickwork

SUBSTRATE MATERIALS | EAST ELEVATION
1:100 @ A3

LDN Architects

KEY

- Original brickwork substrate
- Original sandstone substrate
- New brickwork



SUBSTRATE MATERIALS | NORTH ELEVATION
1:100 @ A3

LDN Architects

KEY

- Original brickwork substrate
- Original sandstone substrate
- New brickwork

SUBSTRATE MATERIALS | SOUTH ELEVATION
1:100 @ A3

LDN Architects

KEY

- Original brickwork substrate
- Original sandstone substrate
- New brickwork

SUBSTRATE MATERIALS | WEST ELEVATION
1:100 @ A3

LDN Architects

7.0

Repair History

62 *RCAHMS 1973 showing Wallhead repair work carried out by Margaret Brodie*

Timeline Summary History of Repairs & Alterations

APK Wright's *Evaluation of Condition and Significance Study* (2012), included in Appendix K of this report, provides a comprehensive narrative history of external fabric repair work carried out and assessment of the success of each intervention. He divides the history of the house into four periods:

1. 1904-1953 The house in the care of Walter Blackie
2. From 1953 Addressing the Problems: Campbell Lawson
3. From 1972 The future of the House secured by the RIAS
4. From 1982 Acquisition by the NTS and the ensuing debate with the HBCS over repair strategies
5. From 1988 Programme of major remedial work under the guidance of Page and Park and the aftermath

This Timeline summarises what is known about the extent and type of alteration and repair work carried out at The Hill House during these periods. It demonstrates that problems with water ingress have plagued the house for much of its life and that a variety of approaches to curing its problems have been implemented. It also demonstrates the extent to which original fabric has been altered, replaced or removed entirely.

The timeline is based on the following principal sources:

- *Evaluation of Condition & Significance Study*, Wright (2012)
- The University of Glasgow, Mackintosh Architecture website (www.mackintosh-architecture.gla.ac.uk) Hill House Chronology
- Reports and analytical drawings prepared by Philip Schreiber, NTS Buildings Surveyor, who was the first to investigate and attempt to catalogue the extent of repair works carried out over the life of the house
- Survey and Repair reports and drawings prepared by The Boys Jarvis Partnership and Page & Park Architects.
- 2010 review of NTS archival information by Rosanne Watts, titled *Hill House: Chronology of Building Repairs Since 1972*

A fuller Chronology which cross-references sources is included in Appendix AD of this report. There are however significant gaps in current understanding which should be addressed by further investigation of NTS, Page & Park and Gillespie, Kidd & Coia archives.

The House in the Care of Walter Blackie

1902 In early spring Walter Blackie purchases the site and Charles Rennie Mackintosh is appointed to design The Hill House.

1904 The Blackies move into The Hill House in 1904. Constructed by Traill & Son Ltd.

1912 Walter Blackie asks Mackintosh to carry out alterations to the house:

- The flat roof of the single storey east service wing (running N-S) is replaced with a pitched roof, requiring a gable at the south end.
- The working kitchen is moved to the annex where the scullery and press had been originally and the former kitchen becomes a staff room.
- The Drawing Room is redecorated.
- A lean-to is added to the north-west corner of the House between the main stair and the west elevation. *(A Boys Jarvis marked-up elevation drawing indicates that this was installed by Blackie. We assume that this was installed during this period of alteration but it could have been later. It was taken down after 1973 but before 1982, possibly by Gillespie, Kidd & Coia.)*

1904 - late 1930s Schreiber's elevation drawings with repairs marked-up indicate areas of work carried out by Traill & Son. Works highlighted by Schreiber include:

- Unspecified work at the window cills at the east elevation.
- A length of garden wall at the east.
- Various areas on the west, north and south elevation (below eaves, bellows cills, at parapets etc.)

(These areas correspond to some areas highlighted by Agnes Blackie in the late 1940s (1949 approx. see below). However, Wright reports that Maitland was hired later by Blackie to take over from Traill & Son who had responsibility for the House until the late 1930s. Either Schreiber was wrong or possibly these repairs were carried out by Traill & Son and then carried out again by Maitland in the 1940s)

c1949 Agnes Blackie remembers the roughcast of the west gable was renewed, as well as areas around the courtyard. Inside, the damp issues with the west gable meant the paneling surrounding the fireplace in the Library needed repair and problems were reported with the wall behind the bed in the Master Bedroom. The roughcast to the south garden elevation may also have been renewed 'sometime thereafter'.

Addressing the Problems: Campbell Lawson

1953 Walter Blackie dies and the house is sold to T.Campbell Lawson.

c1954 Schreiber's markup shows 'Maitland builders' who worked on the House from the late 1930s to around 1959. This work is separate to the highlighted works by Margaret Brodie although she also used Maitland builders to carry out the works later from 1957-59. With reference to the elevation drawings, works carried out include:

- Work to the large chimney at the north attic roof pitch.
- Works to the entirety of the north-east gable.
- Works to the east wing's elevation to the north courtyard (Schreiber's mark up notes 'not cracked but totally boss and came off in sheets, 1954?' indicating that the render had definitely failed by this point).
- Works to the walls below the angled bay window at the former School Room (east elevation).
- Works to the majority of the west elevation gable.

1957-1959 Repair works specified by Margaret Brodie are carried out by Maitland, local builders:

- The freestanding redundant chimney-head in the north-west corner of the house is removed *(NB. this could have been taken down during the Blackie's ownership. It is not rebuilt).*
- At the west elevation, the gable skews are covered in sheets of lead (including the parapet to the flat roof at the north end) and cracks to the render of the chimney-head are re-pointed. Chimney cans may have been removed at this time and head of the chimney sealed off *(unclear if this just the west gable or throughout the house).*
- The parapet walls of the main staircase are covered in sheets of lead.
- At the west of the Dining Room south gable the parapet wall and chimney head are removed and the roof extended to cover the wall-head.
- The chimneyhead at the middle north gable facing the courtyard is removed including the skews at the middle gable of the north elevation.
- Skews are removed at both ends of the single storey north range (running W-E) and the roof extended over.
- Lead is installed at the flat areas of the dormer cill at the former School Room.
- Steel lintols at the window to the WC on the west elevation are renewed.
- The curved beam at the Master Bedroom window bay was also probably replaced and the roughcast renewed in this area.
- From 1953-72 the roughcast is said to be largely unaltered except for repairs associated with the removal and alterations to parapets/skews/chimney-heads and in minor local areas.

The future of the House secured by the RIAS

1972 The Hill House is acquired by the Royal Incorporation of Architects in Scotland after initiatives to take the house into public ownership fail.

1973-1974 RIAS appoints architects Gillespie, Kidd & Coia to convert the service wing and bedrooms (north-east and east areas of the house) into flats. Work completed July 1974. This work includes (but is not limited to):

- Internal alterations to the walls and services.
- The north stair to the second floor is blocked off.
- A new entrance door is added at the base of the spiral stair.
- New windows are installed at the east elevation ground floor.

External works carried out later included the following:

- The main chimney on the west gable is rebuilt (chimney stack above main entrance), roof repaired, harling reinstated, chimney capped.
- The boundary walls, the screen walls and the wrought iron gates are reconstructed.
- The roughcast is repaired (perhaps complete re-rendering of all elevations, chimneys stacks and the boundary wall, although more evidence of this is needed to confirm).
- The chimney-head is reinstated adjacent to the south gable above the Dining Room; the original parapet and roof arrangement is reinstated.

1979 Maintenance on the Hill House is carried out (cleaning out rainwater goods, overhauling slating and leadwork as necessary) including work at the north chimney-stack in the west attic that had been leaking.

1979 Architect W.T.Davie and Associates is appointed by the RIAS.

1981 Works by W.T.Davie are completed. A storm in 1981 had caused damage to render at high level. The repair work included:

- The large west gable chimney-head (north) is again taken down *(Not sure if this was done at this time or whether it had already been carried out by Gillespie, Kidd & Coia. Was this chimney head taken down and rebuilt twice within ten years?)* and rebuilt in calcium silicate bricks. PVA adhesive may have been applied.
- The roughcast is renewed to the chimney-head adjacent to the south gable above the Dining Room.
- Various cracks in the render are cut out and refilled across the building.
- At the east elevation the chimney is rebuilt and reharled. The flues for the chimney were also sealed.

1982 W.T.Davie reports that chimney-head flashings have been renewed and roof repairs carried out. Roughcasting in abeyance.

Acquisition by the NTS and the ensuing debate with the HBCS over repair strategies

1982 The House is acquired by the NTS. The Boys Jarvis Partnership is appointed as architect.

1983-1986 A two-phase programme of repair and restoration works in this period by The Boys Jarvis Partnership, carried out by Stewart & Shields Ltd of Helensburgh.

- Complete reslating of all roof pitches in new (West Highland slates from commercial sources) or salvaged slate from the roof with new underlay and new concrete ridges.
- All parapets and chimneys (9No.) are rebuilt to incorporate a DPC and re-rendered.
- Gable parapets and chimneys removed by previous owners are restored.
- The north-east gable of the east wing is refaced in brickwork (Class 5 common bricks grouted to cope of masonry wall, sound stones projecting to the face of the wall were kept), new brick-cement (precast concrete) skew copes on lead DPC are installed and leadwork weatherproofing details upgraded/overhauled behind (secret gutter, apron flashings, soakers and flashings), lintols and cills are replaced with pre-cast concrete on lead DPC, cavity ties are installed where required, a stepped lead flashing is installed at the chimney-head, flue liners are installed, the lower window is replaced, the middle window is either repaired or replaced, the entire gable is re-rendered in three-coat roughcast, experimental resin injection and spray-on waterproofing treatment is carried out, internally some walls are relined on timber framing,

(The BJP drawings dated April 1983 note 'three-coat roughcast on stainless steel Expamet', also badly damaged stone is replaced in engineering brick, specific note for Class B engineering brick to chimney-stack but in Nov 1983 the BJP proposed replacing in brick entirely rather than replacing individual defective stones and installing SS backing.)

- Works are carried out to the west gable: new pre-cast copings to west gable wall-head and parapet, main chimney (west gable?) taken down to lead tray level and rebuilt, Cloakroom flat roof is rebuilt, flat roof over west bay window rebuilt.
- South-west gable (assume above Dining Room where issues are ongoing) chimneys and parapet rebuilt and re-rendered.
- South-east gable chimney rebuilt and re-rendered.
- The large chimney at the north attic roof pitch is rebuilt with bitumen coated lead tray.
- The courtyard gable is restored.
- Staircase parapet rebuilt with precast copings and re-rendered.
- Some works to 'eliminate faults in joints between the old and new render on the stair tower'.
- Generally the render is checked. Boss or severely cracked render is cut out and patch repaired *(unsure of extent or exact locations).* The elevations are cleaned down, loose particles removed from hairline cracks and the building is lime-washed paying particular attention to brushing well into hairline cracks, 'expandite 600 colour grey' is used to point all cracks. Some cracks are opened up to allow them to be filled in the depth of the render,
- Some structural modifications are carried out internally including: the addition of brick piers in the solum to decrease spans of overloaded joists (including localised foundations/underpinning), two pairs of steel joist rafters are inserted in the east wing roof above the living room as restraints and a new steel joist beam is inserted across the bedrooms at ceiling level, a buttress is formed at second floor level within the wall at the internal angle of the east wing to counteract the trust of the valley rafter above.
- Internal works in this period include tackling various areas of dry and wet rot. The pine paneling and plasterwork in the Dining Room south-west corner is removed and replaced and the ceiling joists are replaced *(presumably due to rot).* Assume that ceiling joists affected by rot in the Drawing Room are also replaced. The first floor passageway also has some linings stripped and replaced although the reason for this is currently not clear.

1984 J Ashurst visits with I Maxwell to discuss repairs to prevent water ingress. Agreed render injection with polyester resin, following a trial panel supervised by Ashurst.

1984 Doig & Smith Cost Estimates – reproofing, 60% new slates, new underfelt and new concrete ridging, repairing lead work not repaired in phase 1. Rebuilding 7 No. chimney heads, incorporating lead tray. Rebuilding copes incorporating dpc, temp pointing of window cills. Estimated to begin on site May 1984. Rebuilding of wallhead not calculated as assume proposed resin injection will work.

Programme of major remedial work under the guidance of Page & Park and the aftermath

1988

Page & Park Architects is appointed to continue the programme of repairs. There is a lengthy discussion over the next period into removal of render, use of silane treatment/consolidant and pinning back the render. Finally, it is agreed that the render should be pinned back with the use of 6.35mm dia. (some records say 8mm dia.) carbon rods secured using low viscosity epoxy resin to pin back boss render ('Drill 7mm holes through 'boss' roughcast and into masonry to a total depth of 150mm deep at a downward angle of 15 degrees from the horizontal at regular centres horizontally and vertically to give 10 fixing points per square metre'). Grouting all over is not successful due to the unevenness of the bossing; localised grouting was used where possible in addition to the pinning back of the harling. Some render was replaced but this was kept to a minimum.

1989

Works carried out include:

- Securing of damaged/boss areas of render with carbon fibre rods.
- Some render is removed and replaced (exact areas unknown) the specification is as follows: cut back areas of defective harling, rake out joints and re-point brickwork as required, dampen surface and apply one coat of Febond SBR and OPC mixed 1:1 (priming coat), thrown on 10-12mm thick layer of mortar (undercoat) and scratch to provide key, lay 10mm thick coat of mortar (final coat) straightened with a rule, throw wet dash coat over.
- Repainting of the exterior in a uniform grey colour based on paint analysis.
- Replacement of all window cills (existing slate removed?) – existing masonry and render removed at the cill, masonry reinstated (unsure if replaced existing or if new) with lead DPC below (only projecting through scratch coat), render reinstated.
- Associated repairs to windows, pointing etc.
- Paint is removed by a light (assumed dry?) grit blasting after chemical strippers (Keim Biostripper and Keim Latexstripper) were ineffective.
- An algicide treatment is applied, external cracks in the render are filled with a brushed weak cementitious mix, a three-coat Keim mineral paint is applied.
- Two lengths of retaining wall in the garden are dismantled and rebuilt and the boundary wall repaired.
- The Library ceiling is replaced. Original stenciled wallpaper in the White Bedroom is uncovered.
- Smoke detection and fire alarm systems are installed.
- Car and coach parking is formed to the north of the house.
- All render is stripped from Garden Round House, only 'specific areas of render on main house stripped'.

1987-1998 The east wing is opened up to the public with a tearoom in the restored kitchen served from an upgraded kitchen. Partitions dividing the old laundry and wash house are reinstated to create a shop. A store room door is reopened.

1989-1992 A fire alarm and fire detection system is installed. Empty rooms on the first floor are redecorated in Mackintosh colours.

1995-1997 Floor strengthening is carried out. Schreiber report and drawings dated 4th September 1995 details the areas covered. This was mainly to upgrade the floors from domestic loading to the larger loads of visitors to the House (an average of 150 per day increasing to 400 on a busy summer afternoon). Additional brick piers are installed under central support beams in the solum. Gavin Walker (grandson of Walter Blackie) is the structural engineer for the project. Some stud walls are rebuilt (east wing ground and first floor). At the First Floor joists are strengthened below by the addition of steel channels or steel fitted plates based on the loading requirements. At the Second Floor joists are also strengthened and new floor beams are installed.

1997 Further render patch repairs are carried out.

2002/2003 Four packages of work were carried out including general repairs to the boundary walls, garden shed and garage (including significant removal of asbestos containing materials), decoration, electrical works and glasshouse repairs. Within package three:

- The exterior of the house and lodge is painted
- Masonry, timber and metalwork (assumed general overhaul)
- Various render repairs to the House and lodge
- Selected roof repairs to the House
- New electrical distribution board etc.
- Thermographic survey of the House (to assess the current condition of the render). From this a render repair program was drawn up but work still in abeyance.

2005 The House is redecorated externally. Glazing putty and mastic is replaced, timber windows are repainted, rust on the metal windows is removed and treated and soffits, jack rafters, gutters and downpipes are redecorated. The render is not included as repairs were still under discussion.

2006 Extensive rebuilding of the north gable of the middle range due to water penetration. Render is removed and the substrate of poorly fired brick was discovered to be in an advanced state of deterioration. ‘The upstand to the adjoining skews was lifted up by 100mm to overcome problems with the detailing’.

2014 Unspecified repairs and repainting (although not in all areas). The render is patch repaired and repainted with a mineral paint treatment. It is understood to be Keim Soldalit and Algicid-Plus treatment.

2016 A team led by LDN Architects appointed to prepare a Research & Development study describing the causes of water ingress problems and the process by how they might be cured.

2016 Quinquennial Survey update by LDN Architects with Irons Foulner M/E Engineers and David Narro Associates, Structural engineers.

2019 Big Box enclosure is erected to protect the external fabric of the house from further water ingress and allow it to dry out. Designed by Carmody Groake Architects.

2021 Research & Development Conservation Management Plan completed.

Summary

External Works carried out (1912-1981) includes:

- Flat roof of single storey east service wing changed to pitched roof with new gable
- Work at the window cills of the east elevation
- Various repairs to the render on the west, north and south elevations
- Renewal of the west gable roughcast
- Renewal of areas of roughcast at north courtyard
- Renewal of areas of roughcast at south elevation
- Rebuilding of the large chimney at north attic roof pitch
- Repair/renewal of the entirety of the north-east gable and return elevation to courtyard
- Repair/renewal of the render to the wall below the east bay window
- Removal of the redundant chimney at the north-west above the Cloakroom
- Chimney-head render repointed
- Chimney-heads removed (south gable, north courtyard gable) roofing details altered
- Several if not all chimney-heads rebuilt and re-rendered completely
- Gable skews and parapets covered in sheets of lead
- Skews removed at the north range to both ends and roof extended over
- Lead installed at the east dormer window cill
- Steel lintols at the west WC window renewed
- Curved beam at the master bedroom window bay replaced and roughcast renewed
- New entrance door to the base of the spiral stair tower
- Chimney at west gable reinstated, roof repaired and harling reinstated
- Chimney at north courtyard gable reinstated with render
- Chimney adjacent to south gable reinstated with render
- Localised roughcast repair generally across all elevations
- Chimney-head flashings renewed
- Roof repairs generally

Paul Schreiber's floor strengthening report dated 4th September 1995 summarises all the work carried out by the NTS at that date - a period of 14 years (1982-1995).

- Complete reslating of the roofs (inc. new concrete ridges)
- Complete renewal of roof leadwork
- Associated renewal of rotten sarking and rafters
- Strengthening of roof structure on east wing
- Rebuild chimneys, gable wall heads and parapets
- Reface entire north gable
- Extensive repairs to existing render or other walls
- Repairs to cracked window sills
- Consolidation and painting of render
- External repainting
- Eradication of outbreaks of wet and dry rot
- Interior decoration and plaster repairs
- Restoration of historic decoration
- Installation of intruder alarm
- Installation of fire alarm
- Installation of moisture monitoring system
- Partial rewiring electrical installation (RIAS had party rewired the building)
- Fitting carpets
- Provision of toilets, tearoom, kitchen, shop
- Provision of car park
- Restoration of garden
- Rebuilding two retaining walls
- Restoration of wrought iron gates
- Repairs to boundary walls

- Renewal of rotten gates and trellises
- Repair garden drainage
- Divert water conduit
- Repair and upgrade property manager's cottage

External Works carried out (1996-2021) include:

- Alterations to the cottage
- Installation of the Box enclosure
- Drainage works associated with the installation of the Box
- Repainting of the external walls
- Remedial works to areas where work had already been carried out as above.

Architect / Surveyor / Building Professional Timeline

1902 - 1912	Honeyman Keppie & Mackintosh (Charles Rennie Mackintosh)
1928	Robert Wemyss, Helensburgh architect (Works gardener's cottage)
1953 - 1959	Margaret Brodie
1972 - 1979	Gillespie, Kidd & Coia
1979 - 1982	W.T.Davie & Associates (Bill Davie)
1982 - 1988	The Boys Jarvis Partnership (Geoffrey Jarvis) until partnership dissolved.
c1982 - 1989	Ingval Maxwell, Historic Buildings Council for Scotland Architect; Neal Sharp, NTS
1988 - c1990	Page & Park Architects (Brian Park)
1989 - 2008	Philip Schreiber (NTS Buildings Surveyor)
2006 - present	Bryan Dickson (NTS Head of Buildings)
2009 - 2016	William Napier (NTS Building Surveyor)
2012	Andrew P K Wright, Conservation Architect
2016 -	LDN Architects (Mark Hopton)

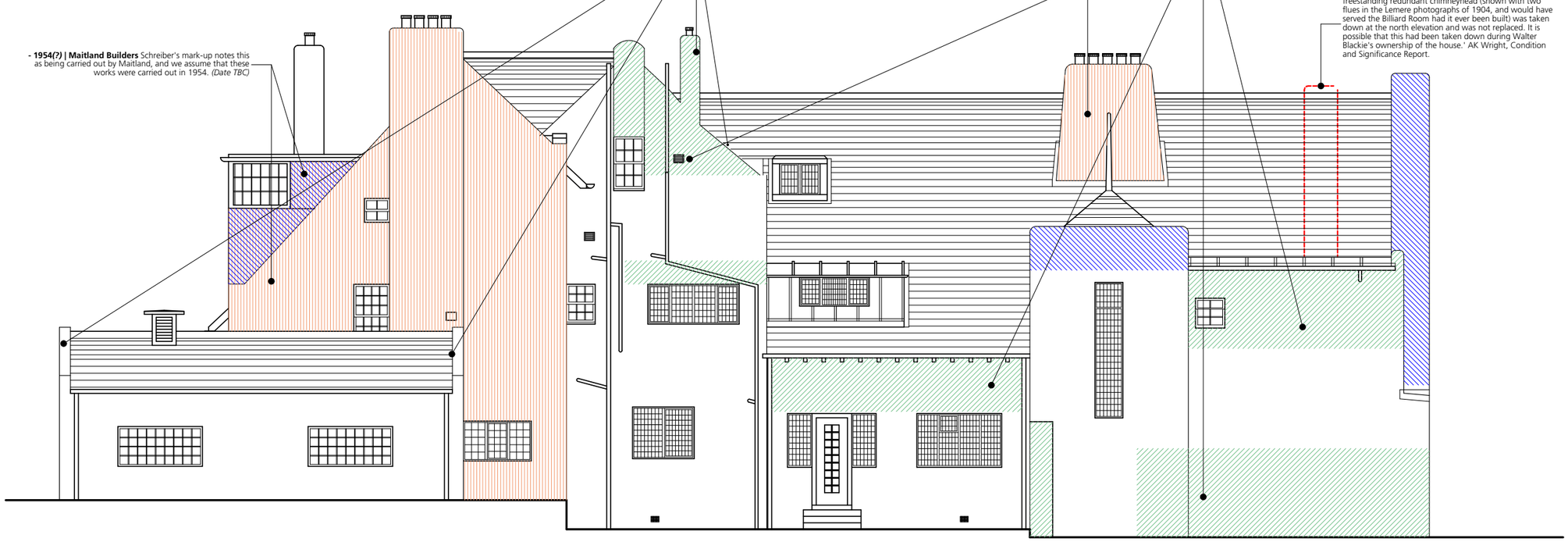
The following drawings describe our understanding of repair and alteration work carried out based on documentary evidence sourced to date

HISTORIC REPAIRS | EAST ELEVATION
1:100 @ A3

LDN Architects

KEY

- 1904 - Late 1930s | 'Traill & Son Ltd.'
- 1954*(?)* | 'Maitland Builders' (Mr Copeland (Maitland Builders))
- 1953-1972 | 'Campbell Lawson'
- 1953-1959 | 'Margaret Brodie, Arch'
- 1973-74 | Gillespie, Kidd & Coia
- 1981, 1982 | 'W.T.Davie/Bill Davie'



HISTORIC REPAIRS | NORTH ELEVATION
1:100 @ A3

LDN Architects

HISTORIC REPAIRS | SOUTH ELEVATION
1:100 @ A3

LDN Architects

KEY

- 1904 - Late 1930s | 'Traill & Son Ltd.'
- 1954*(?)* | 'Maitland Builders' (Mr Copeland (Maitland Builders))
- 1953-1972 | 'Campbell Lawson'
- 1953-1959 | 'Margaret Brodie, Arch'
- 1973-74 | Gillespie, Kidd & Coia
- 1981, 1982 | 'W.T.Davie/Bill Davie'

- 1953-1959 | Margaret Brodie, Architect
"At the west elevation, the skews to the gables were covered in sheets of lead, a solution which was applied also to the parapet wall surrounding the main staircase where steps were introduced to the line of the parapet."

- 1953-1959 | Margaret Brodie, Architect
"Visually, the most significant changes were at the S.W. corner of the E. wing, where the chimney-stack was taken down, the parapet removed, and the roof extended to cover the wallhead."
"Similarly, at the return wall to the Dining Room south gable, the parapet wall and chimneyhead were removed and the roof extended so that it covered the wallhead; as a consequence of this change (for which consent was sought for, and granted by the Dunbartonshire County Council) the profile of the stepped wall planes were altered once the parapet had been removed to accommodate the line of the roof. "
- 1974 | Gillespie, Kidd & Coia. Chimney and parapet reinstated 'The repair of the roughcast, the reconstruction of the boundary walls, the screen wall, the wrought iron gates and the missing chimney on the west gable are among the most immediate works to be undertaken' by the trustees of The Hill House. "A chimneyhead was erected to reinstate the original chimneyhead taken down by Campbell Lawson adjacent to the south gable above the Dining Room, and the original parapet wall arrangement was reinstated (much against Mr Lawson's earnest pleading that it should never be reinstated for the further damage that would result to the interior!)."

- 1954*(?)* | Maitland Builders Schreiber's mark-up notes this as being carried out by Maitland, and we assume that these works were carried out in 1954. *(Date TBC)* Schreiber's mark up notes 'not cracked but totally boss and came off in sheets, 1954?' indicating that the render had definitely failed by this point.

- 1904 | Originally brick (photographic evidence)
- 1957 | Margaret Brodie, Architect Unsure as to exact works bur repairs carried out by Margaret Brodie in 1957. "…While her advice was restricted to the troublesome chimneyheads of the west elevation, within a short space of time numerous problems were encountered, requiring elements of construction at high level to be either removed, or modified." "The chimney cans were probably removed at this time, and the head of the chimney sealed off. The visual impact of pointing up the many cracks to the chimneyhead could be seen in photographs for years to come." Minor repairs were entrusted to local tradesmen. A photograph of the west elevation in 1969 shows lead dressed over the skews between the two chimney heads and at the parapet to the flat roof. (Photo by Kenneth Lawson.)"
1974 | Gillespie, Kidd & Coia "Phase 3 survey of dilapidations of external fabric. J McLeod, Clerk of Work to prepare along the lines of HBC Inspector's report (30/07/1974 Progress Report 7 by G,K&C). harling repairs, **reharl all elevations and chimney stacks** and boundary wall – general condition poor and boss. Chimney stack above main entrance replaced, roof repaired, harling reinstated, chimneys capped (according to P Schreiber report)
- 1981 | W.T. Davie, Architect Rebuilt in calcium silicate bricks and roughcast. "Among the most significant repairs to be undertaken had been the taking down and rebuilding of the large chimneyhead at the west gable which had caused long standing problems, which was rebuilt in calcium silicate bricks." **17 February 1981 |** John F Gillespie & Son (Builders) Ltd letter to W Davie (Architect) – advise strip on render to mock chimney head over main entrance, apply one coat of PVA adhesive and renew roughcast, because of penetration of water. **20 May 1981** | W Davie Fabric Committee Report – chimney brickwork completed and coated, roughcasting to occur. Contractor instructed to cut out and refill number of cracks on building

- 1904 to Late 1930s Works by Traill & Son Ltd. (Traill of Helensburgh, local contractor who was responsible for care of HH from completion to late 1930s.)

- 1954*(?)* | Maitland Builders Schreiber's mark-up notes this as being carried out by Maitland, and we assume that these works were carried out in 1954. *(Date TBC)*

HISTORIC REPAIRS | WEST ELEVATION
1:100 @ A3

LDN Architects

These images demonstrate the degree to which fabric has changed and why it is so difficult to assess what fabric dates from what period and define what is Authentic:

- The 1905 photo shows a more slender chimney in the angle between the South Elevation and Gable and differs in design from the 1903 concept sketch (ref p36)
- The proportions of the chimney have changed to become more slender by the time the house was completed.
- By the 1970s the chimney was removed and the roof profile changed to solve problems of water ingress.
- The chimney was reconstructed in the 1970s by Gillespie Kidd and Coia.
- It was taken down again "temporarily" by Boys Jarvis in 1983 and rebuilt.

The chimney is still leaking and causing damage to the fabric and rooms below.

Bedford Lemere 1905

RCAHMS 1973

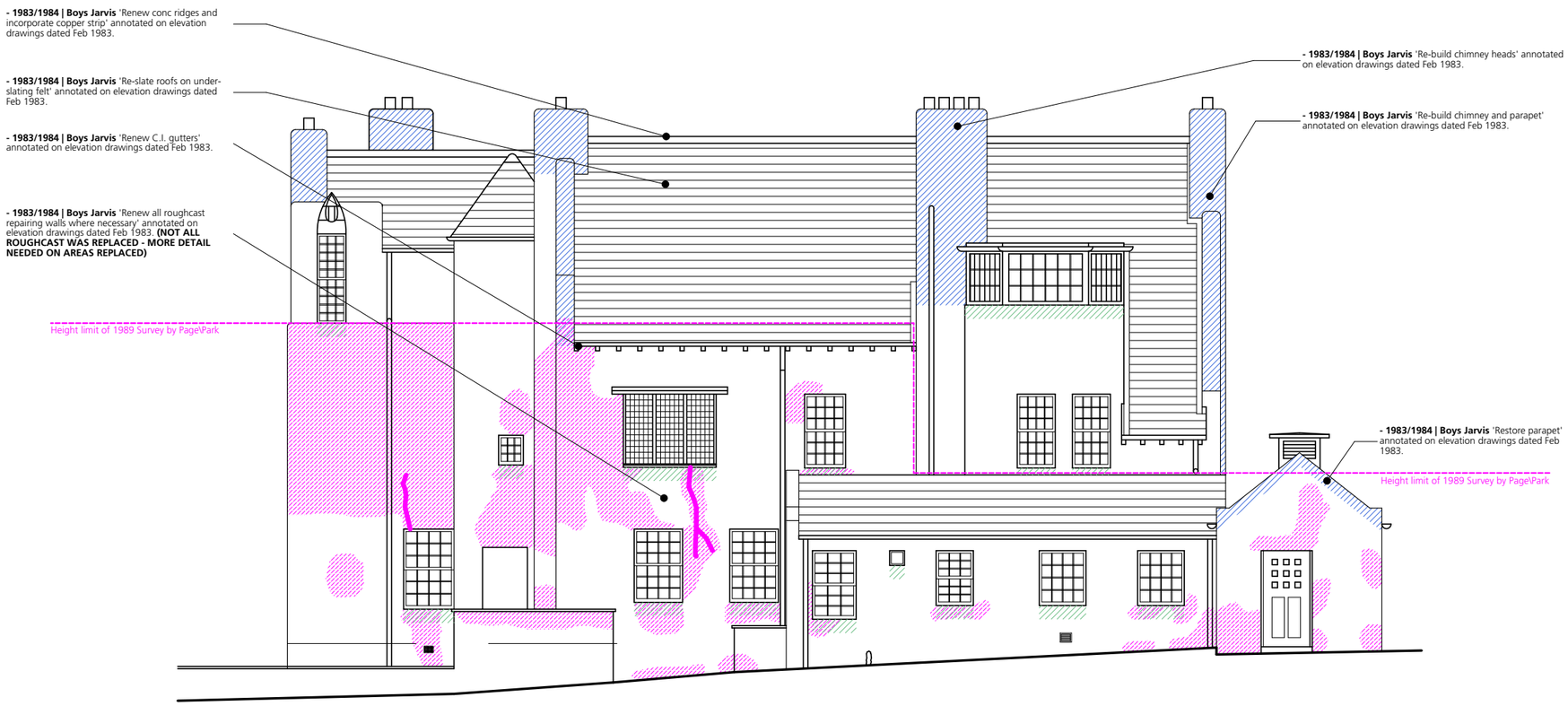
NTS c1983

Boys Jarvis 1983

2016

KEY

- **1983-1986 | The Boys Jarvis Partnership**
- **1989 | Page\Park**
- **1989 | Page\Park - Assumed areas when bossed roughcast has been pinned back (Based on P\P survey of render)**



EAST ELEVATION
1:100 @ A3

LDN Architects

KEY

1983-1986 | The Boys Jarvis Partnership

1989 | Page\Park

1989 | Page\Park - Assumed areas when bossed roughcast has been pinned back (Based on P\P survey of render)

- 1983/1984 | Boys Jarvis 'Restore chimney and gable parapet' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Re-build parapets' and 'Re-build chimney' annotated on elevation drawings dated Feb 1983.

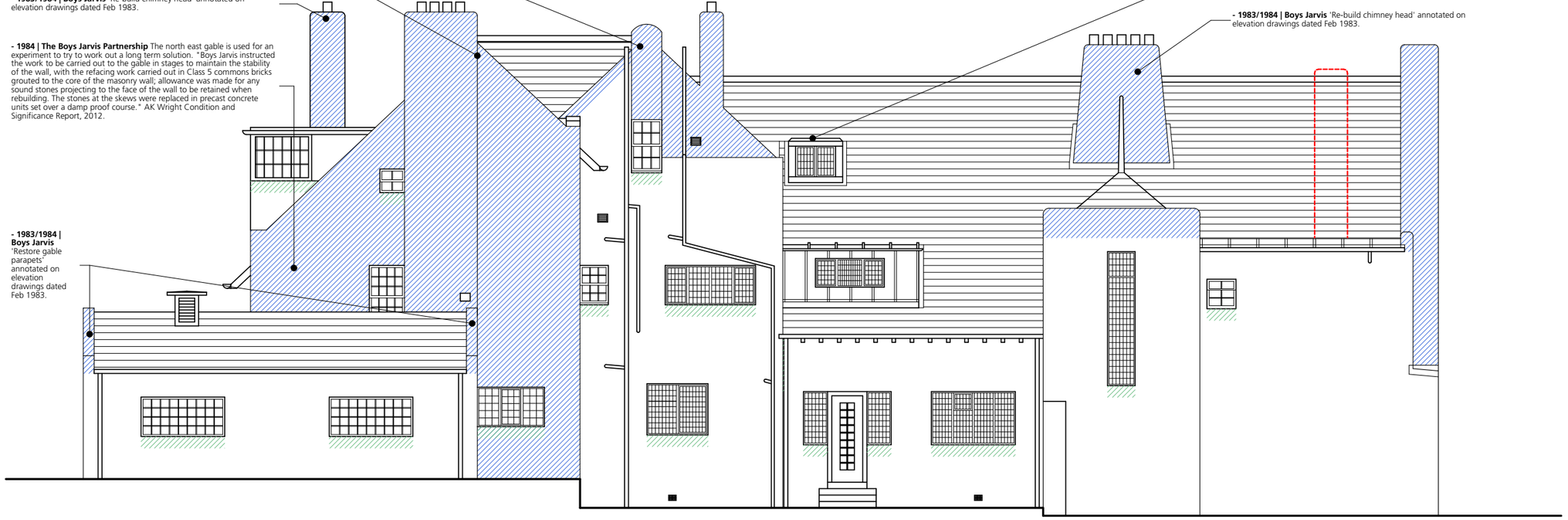
- 1983/1984 | Boys Jarvis 'Re-build chimney head' annotated on elevation drawings dated Feb 1983.

- 1984 | The Boys Jarvis Partnership The north east gable is used for an experiment to try to work out a long term solution. "Boys Jarvis instructed the work to be carried out to the gable in stages to maintain the stability of the wall, with the refacing work carried out in Class 5 commons bricks grouted to the core of the masonry wall; allowance was made for any sound stones projecting to the face of the wall to be retained when rebuilding. The stones at the skews were replaced in precast concrete units set over a damp proof course." AK Wright Condition and Significance Report, 2012.

- 1983/1984 | Boys Jarvis 'Restore gable parapets' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Re-build dormers' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Re-build chimney head' annotated on elevation drawings dated Feb 1983.



NORTH ELEVATION
1:100 @ A3

LDN Architects

KEY

- **1983-1986 | The Boys Jarvis Partnership**
- **1989 | Page\Park**
- **1989 | Page\Park - Assumed areas when bossed roughcast has been pinned back (Based on P\P survey of render)**

- 1983/1984 | Boys Jarvis 'Renew all roughcast repairing walls where necessary' annotated on elevation drawings dated Feb 1983. **(NOT ALL ROUGHCAST WAS REPLACED - MORE DETAIL NEEDED ON AREAS REPLACED)**

- 1983/1984 | Boys Jarvis 'Renew window leads' annotated on elevation drawings dated Feb 1983.

- 1984 | The Boys Jarvis Partnership "Investigate and stabilise the south elevation crack on the west intersection of first floor bay window; cut out, fill and reseal". Ingval Maxwell Report, 22nd Nov 1983 - assume this work was carried out by Stewart and Shields in 1984.

- 1983/1984 | Boys Jarvis 'Renew conc ridges and incorporate copper strip' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Re-slate roofs on under-slating felt' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Renew C.I. gutters' annotated on elevation drawings dated Feb 1983.

- 1983-1984 | The Boys Jarvis Partnership * The south chimney is temporarily removed to stop leak which caused dry rot in the room below.* Restoration Work at the Hill House, photograph and caption.
- 1983/1984 | Boys Jarvis 'Restore chimney' annotated on elevation drawings dated Feb 1983.

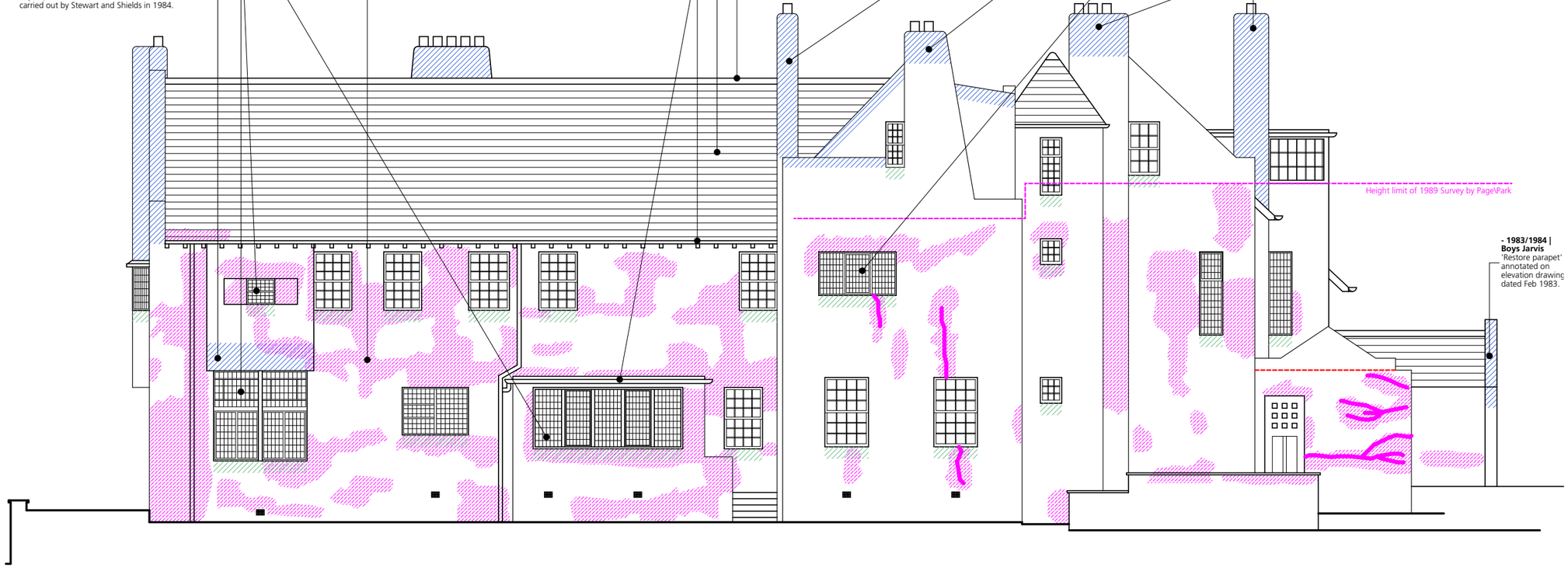
- 1983/1984 | Boys Jarvis 'Re-build chimney head and parapet' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Renew window leads' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Re-build chimney heads' annotated on elevation drawings dated Feb 1983.

Height limit of 1989 Survey by Page\Park

- 1983/1984 | Boys Jarvis 'Restore parapet' annotated on elevation drawing dated Feb 1983.



SOUTH ELEVATION
1:100 @ A3

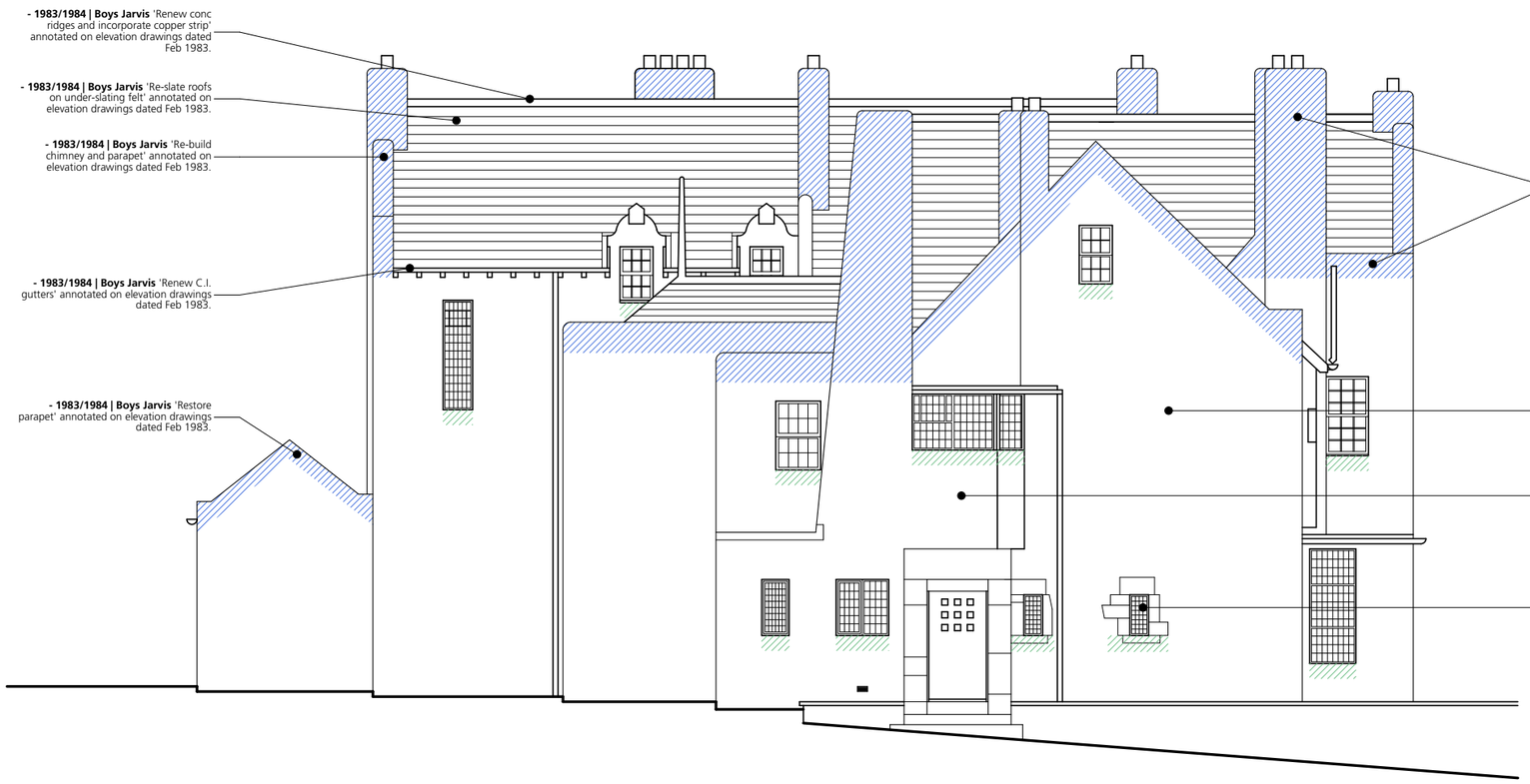
LDN Architects

KEY

1983-1986 | The Boys Jarvis Partnership

1989 | Page\Park

1989 | Page\Park - Assumed areas when bossed roughcast has been pinned back (Based on P\P survey of render)



- 1983/1984 | Boys Jarvis 'Renew conc ridges and incorporate copper strip' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Re-slate roofs on under-slating felt' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Re-build chimney and parapet' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Renew C.I. gutters' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Restore parapet' annotated on elevation drawings dated Feb 1983.

- 1983-1984 | The Boys Jarvis Partnership "The south chimney is temporarily removed to stop leak which caused dry rot in the room below. " Restoration Work at the Hill House, photograph and caption.
- 1983/1984 | Boys Jarvis 'Restore chimney' annotated on elevation drawings dated Feb 1983.

- 1983/1984 | Boys Jarvis 'Renew all roughcast repairing walls where necessary' annotated on elevation drawings dated Feb 1983. *(More information is needed on the roughcast repairs.)*

- 1984 | Boys Jarvis with Stewart and Shields
Various minutes over the period of works around 1984 detail the works to the west gable. **"16 October 1984 |** Minutes- cocooning over whole house, west gable wall head finished except NW corner. Flat roof over west bay window being rebuilt, staircase coping being rendered" **"25 October 1984 |** Minutes – west gable wallhead complete…"

- 1983/1984 | Boys Jarvis 'Renew window leads' annotated on elevation drawings dated Feb 1983.

WEST ELEVATION
1:100 @ A3

LDN Architects

"By combining the infra-red thermographic survey, the 3D scan and the microwave readings, we have a very powerful tool to aid our technical understanding of the complex problems at the Hill House."

Richard Williams,
General Manager, Glasgow & West

8.0

Documentary Review

82 *2021 Showing Visitor pod in background*

Documentary Review

In contrast to Mackintosh's well documented despair at the lack of contemporary interest in his work, there is now no lack of literature about all aspects of his work. Professor Pamela Robertson, in a keynote address to the University of Barcelona coupDefouet International Congress in 2015, provided an overview of the critical literature surrounding his career, dividing it into five broad phases:

1. CRM Lifetime — the Critics
2. 1928-1960 — Architectural Historians and Modernism
3. 1960-1980 — Collection Research
4. 1980-1995 — Contextual and Interpretive
5. 1995-2015 — Internationalism

Looking to the future, she also highlighted the growing potential of online digital tools to increase knowledge about Mackintosh and his legacy and disseminate it more widely in new ways.

Within this overall body of knowledge, information of direct relevance to this study can be categorised as that covering:

- **The philosophy and principles of modern architecture conservation.**
- **Mackintosh related research which features aspects of The Hill House.**
- **The behaviour and conservation of building materials similar to those used to construct The Hill House and those used, subsequently, to repair it.**
- **Surveys and studies specifically related to the history, condition and authenticity of the Hill House.**
- **Comparator projects**

A selected list of articles, websites and books and collections which reference different aspects of the design of The Hill House is included in the Bibliography at the rear of this report. The most relevant sources of information identified in relation to this research and development study are summarised below:

The philosophy and principles of modern architecture conservation

Websites:

https://www.getty.edu/

The Getty Foundation's *Keeping It Modern* initiative supports the conservation of significant 20th century architecture and the Report Library makes available the resulting conservation plans and technical reports produced.

https://www.getty.edu/foundation/initiatives/current/keeping_it_modern/report_library/index.html?fbclid=IwAR3KDcYPTV6IZXFByQmcLFC3s3G2lU0B1w6zvHwsorjXCjBo9Lf70eaq3lM

AATA online is a free research database containing abstracts of literature related to the preservation and conservation of material cultural heritage. It has been managed and published by the Getty since 1983. AATA Online contains over 156,000 records and adds approximately 4,000 new records each year through regular updates.

https://aata.getty.edu/primo-explore/search?vid=AATA

Publications:

1966 ICOMOS, International Charter of the Conservation and Restoration of Monuments and Sites (The Venice Charter)

1998 English Heritage. *Modern Matters*

Examines the philosophical, methodological, and practical problems associated with conserving our recent past.

2001 English Heritage. *Preserving Post-War Heritage*

Collection of papers from English Heritage's 1998 conference on the care and conservation of mid-twentieth century architecture.

2001 English Heritage. *Informed Conservation*

Guidelines on techniques for understanding historic buildings and how to apply that understanding to conservation projects

2003 Earl, J. *Building Conservation Philosophy*

An analysis of changing conservation principles and philosophical arguments

2007 Macdonald, Normandin, Kindred (ed). *Conservation of Modern Architecture*

Papers covering different aspects of the conservation of modern architecture.

2013 Australia ICOMOS. *The Burra Charter*

Latest version of the seminal publication which provides guidance for the conservation and management of places of cultural significance.

2014 Cairns & Jacobs. *Buildings Must Die*

An alternative view of conservation promoting the management of decay.

2015 Historic England. *Conservation Principles, Policies and Guidance*

Principles, policy and guidance for the sustainable management of the historic environment

2017 ICOMOS. *The Madrid Document*

Most recent approved version, setting out the approach and principles that should be applied to managing and interpreting twentieth-century sites and places.

2021 Marsden, S and Spearritt, P (ed). *The Twentieth Century Historic Thematic Framework*

Getty Conservation Institute funded publication providing a tool for professionals, heritage agencies, and communities needing to recognize, conserve, and interpret their significant twentieth-century heritage places by structuring areas of research and survey.

Mackintosh related research which references The Hill House

Websites:

www.mackintosh-architecture.gla.ac.uk

University of Glasgow's Mackintosh Architecture project research project which ran from 2010 – 14 and was led by The Hunterian at the University of Glasgow. Richly illustrated database of all known architectural projects by CRM and related information, representing most comprehensive survey of CRM's work, a fuller picture of context in which he worked and broader view of achievements.

www.crmsociety.com

The Mackintosh Society's Newsletter (1973–2007) and subsequently Journal (2008 f.) contains a wealth of useful articles and updates on the Mackintosh heritage and its wider context. These are regularly cited in project entries and biographies. Access is currently limited, but an online index is planned and back copies can be ordered through the Society.

www.gsaarchives.net

The archives and collections of Glasgow School of Art, including items relating to Mackintosh art and design.

Publications:

1904-5 Angeloti, Fernando. *The Hill House Helensburgh, Deutsche Kunst und Dekoration 15*

A glowing description and analysis of The Hill House published shortly after its completion, including Bedford Lemere photographs of the newly completed building.

1952 Howarth, Thomas. *Charles Rennie Mackintosh and the Modern Movement*

First major biography of Mackintosh

1968 Blackie, W. *Memories of Charles Rennie Mackintosh, Scottish Art Review*

The owner's recollections of Mackintosh and the design of The Hill House.

1968 MacLeod, Robert. *Charles Rennie Mackintosh: Architect & Artist*

Desciption and analysis of The Hill House including comparison with Windyhill and other Mackintosh-designed houses.

1973 Pevsner, N and Richards, J M. (ed) *The Anti-Rationalists*

Critical essays including early projects by Mackintosh and his connections with Europe.

1990 Robertson, P. *Charles Rennie Mackintosh: The Architectural Papers*

Critical essays based on Mackintosh's own words and writing including his untitled 1892 lecture on Architecture.

1994 Macauley, James. Charles Rennie Mackintosh: The Hill House

Classic Phaidon Hill House edition, describing The Hill House in words, drawings, pictures and photos.

2010 Macauley, James. Charles Rennie Mackintosh

Description of Mackintosh's life, works and projects

The behaviour and conservation of building materials similar to those used to construct The Hill House and those used, subsequently, to repair it.

Websites:

The websites described above under the section on Mackintosh related research include materials technical appraisals and research. Ranald MacInnes's authoritative essay titled "Mackintosh and Materials is published on the Mackintosh Architecture website and The Getty *Keeping it Modern* Reports also include materials analysis.

Publications:

1992 Park, B. *Cracking up: Hill House, Architects Journal*

2009 Torraca, G. *Lectures on Materials Science for Architectural Conservation*

2011 Wright, A. *Early Portland Cement: Its Use and Influence on Architectural Design*

2014 Cannata, M. The Repair and Alterations of the De La Warr Pavillion (two articles)

2015 MacInnes, R. *Building on Mackintosh* lecture

The archives and collections of The National Trust for Scotland; Historic Environment Scotland; Gillespie, Kidd and Coia Architects; and Page\Park Architects all contain items of relevance to this study and merit further investigation.

Surveys and studies specifically related to the history, condition and authenticity of the Hill House.

Over the last twenty years, a number of diverse and authoritative studies have been commissioned by the NTS to develop a greater understanding of the condition of The Hill House's fabric; the causes of water ingress; and the significance of the property. Whilst there are still gaps in knowledge, particularly in relation to the original design and construction of the house, the reports provide an excellent evidential database and insight into the condition and significance of the fabric of The Hill House and how it has changed over time. The scope and conclusions of each report are summarised below and copies of each report are included in the appendices of this report for ease of reference and in order to collate them properly for the first time:

1983 *Boys Jarvis Repairs Summary*

Selection of information describing extent of repairs, issues arising, and discussions about methodology taking place.

1983 *External Repairs Analysis* (Appendix A)

Prepared by Philip Schreiber, NTS Building Surveyor. A series of annotated elevations summarising his investigations into the sequence and extent of historic fabric repairs.

1989 *Page and Park Repairs Summary*

Selection of information describing extent of repairs, issues arising, and discussions about methodology taking place.

2003 *Infrared Thermographic Render Inspection* (Appendix E)

Prepared by Construction Materials Consultants Ltd, possibly as part of a Quinquennial Survey. The report identifies large sections of render that are believed to have debond and concludes that the condition of the render was worst on the west elevation but deteriorating on most elevations as a result of thermal and moisture movement, frost action, and wind loading.

2005 *A Report on the Paint following and Examination of External Surfaces* (Appendix F)

Prepared by Patrick Baty of Papers & Paints Ltd. The report concludes that much original paintwork has been stripped during subsequent re-painting but, on the evidence remaining, external doors were originally painted a dark brown finished with varnish; both timber and metal framed windows were painted white / off-white; rainwater gutters were painted white / off-white matching the windows; no evidence of original downpipe colours remains; ironwork was black; and harling, based on a sample removed from roofed in void above the kitchen extension, was a pale grey consisting of limewash tinted with charcoal.

2009 A Discussion on its Previous and Future Repair (Appendix G)

Prepared by William Napier (NTS Lead Surveyor). The paper describes the range of water ingress issues being experienced at the Hill House and considers a number of issues relating to how the problems might be addressed, particularly in relation to the harling. It reflects the start of a change in emphasis from preserving existing finishes to a more holistic approach to authenticity and the start of a process which is culminating in this study.

2009 Stained Glass Report (Appendix H)

Prepared by the Stained Glass Design Partnership. The focus of the report is conservation of windows in the Gardener's Cottage but reference is also made to the stained glass in the house itself and an earlier 1993 Report and 1997 Conservation Record.

2012 Report on the Examination and Analysis of Samples taken from the Building Fabric (Appendix J)

Prepared by Construction Materials Consultants Ltd, with the Scottish Lime Centre and the British Geological Survey, as a component of the 2012 Quinquennial Survey. The report includes analysis of the stone and brick and a sample of the roughcast mortar, approximately 30mm thick, which was obtained from the roofspace of the Kitchen extension formed shortly after the house was completed and therefore likely to be a sample of the original roughcast.

The study is the most detailed scientific analysis of the main construction materials at the Hill House. Section 4.0 of the Report, the Summary of Observations, describes the main finding of the materials analysis.

The BGS section of the report concludes that the roughcast mortar sample was made up of a:

- 2mm lime wash layer, originally white in colour, but now soiled and grey
- a wet dash coat of granules up to 5mm in diameter, bound by a mix of probable lime cement and fine-grained sand; moderate to low water permeability
- a second coat of a consistent 15mm thickness of sands in an off-white / very pale grey probable lime cement binder; moderate to low water permeability
- a base coat similar to the second coat but with a larger range of pore sizes with a good bond but no visible sign of a key; moderate to high water permeability

The BGS also concludes that whilst the wet dash coat is virtually impermeable, water penetrates through cracks and finds a main path of penetration between the base coat and second coat. This water saturates the base coat which is more porous and permeable allowing water then to penetrate the stone or brick substrate. The trapped water then dries into the building rather than out through the impervious outer layers.

2012 Evaluation of Condition & Significance Study (Appendix K)

Prepared by Andrew Wright. This study explores the history of water ingress and related repairs to the exterior fabric of the house and argues that authenticity of design is more important than retention of failed external materials.

2016-21 Historic Environment Scotland Monitoring Reports (Appendix Q)

Thermography and microwave moisture content analysis of the external fabric covering the periods before and after the Box was erected. These reports describe the changing moisture content of the external fabric and provide an indication of the speed at which the fabric is drying out.

2005, 2012 and 2016 update Quinquennial Condition Surveys (Appendix S,T,U)

Prepared by various conservation surveyors and architects. These surveys record the changing condition of the fabric of the house over the years on an elemental basis

2016 Chimney Report (Appendix V)

Prepared by Old Mill Chimneys. Provides a condition survey and remedial work recommendations for each flue. Problems identified relate to uncapped flues and defective roughcast.

2012 / 16 Asbestos Surveys (Appendix W,X)

Hazardous Materials Survey in 2012 and subsequent inspections.

2018 Preliminary Timber Decay & Damp Survey (Appendix Y)

Prepared by Hutton + Rostron. Comprehensive timber decay and rot survey which identifies areas of water ingress, previous repairs and outbreaks of rot. Conclusions broadly similar to other surveys in that water ingress is due to wind driven rain through cracks in roughcast, defective wallheads and other weathering details. Chimney flues create moisture routes through fabric. Rising damp is caused by ground water penetration along rear of house as a result of defective ground drainage. Ventilation of underbuilding is also compromised. The accuracy and effectiveness of the moisture monitoring system installed in the early 2000s is questioned.

2018 Fire Strategy Report (Appendix Z)

Fire Engineering and Escape Strategy for Box based on a fire occurring in the House. It covers escape from the Box only and does not cover escape from the interior of the house.

2020 Historic Decorative Schemes Report (Appendix AA)

Prepared by Scottish Wall Paintings Conservators. The report covers the condition of painted decoration in the principal rooms of the house and recommendations for conservation work. Issues arising due to the drying out process and the impact of changing humidity levels are identified and conservation recommendations made. The report also assists in identifying the survival of original decorative schemes.

2016-21 NTS Internal Environment Monitoring Reports (Appendix AB)

A series of reports prepared by Sustainable Heritage Conservation based on the Hanwell environmental monitoring data. The latest report to December 2020 concludes that over the last five years showed significant improvement after 2018. This is likely to be as a result of a combination of three factors that were different for 2020:

- Introduction of conservation heating for the majority of monitored rooms in Dec 2018;
- Installation of the Box to allow the building fabric to dry out, from early 2019;
- Closure for much of 2020 due to Covid-19 lockdown/restrictions.

Performance of the light levels also improved, most likely as a result of closure due to Covid-19.

2021 NTS Interiors Authenticity Study (appendix AC)

The report collates all known interventions relating to the decorative surfaces into one document. It summarises the extent of changes in each room ad therefore also the extent of surviving original fabric.

2021 Digital Documentation and Innovation at the Hill House (Appendix AF)

Point cloud survey of the exterior and interior of the building carried out by HES providing high resolution digital survey information.

Comparator Projects

A number of projects addressing the conservation of 20th century buildings have been completed in recent years. Whilst The Hill House and its coastal location near the top of an exposed hill facing the worst of weather are unique, valuable lessons in relation to technical and philosophical issues can be learned from these comparator projects which include:

- The Glasgow School of Art, C R Mackintosh
- Windyhill, Kilmacolm, C R Mackintosh
- The Willow Tea Rooms, C R Mackintosh
- The Einstein Tower, Potsdam, Erich Mendelsohn
- The Rietveld Schroder House, Utrecht, Gerrit Rietveld
- House in Moscow, Konstantin Melnikov
- De La Warr Pavilion, Bexhill on Sea, Mendelsohn and Chermayeff
- Falling Water, Pennsylvania, Frank Lloyd Wright
- The Guggenheim, New York, Frank Lloyd Wright
- Castle Drogo, Devon, Edwin Lutyens

A study of the performance of 20th century cement-rendered buildings in the Western Isles of Scotland where the air is salty and the exposure more severe than at the Hill House site could also provide valuable lessons.









Top row, left to right: The Glasgow School of Art, Windyhill and The Willow Tea Rooms. Middle row, left to right: The Einstein Tower, The Rietveld Schroder House and House in Moscow
Bottom row, left to right: Falling Water, The Guggenheim and Castle Drogo

Battered by around 190 days of rain each year, the long-term survival of the building is in doubt and there's a real danger of its priceless, Mackintosh-designed interior being lost forever.

The Hill House is 'dissolving like an aspirin in a glass of water'.

NTS

9.0

Condition & Technical Issues

92 *Dining Room showing water ingress through external wall and possible wet bridges in fabric at first floor level as well as chimney flue*

Current Condition

The development of a suitable programme of conservation work at The Hill House should be based on a comprehensive understanding of the technical and philosophical issues related to repair of its fabric. A range of technical investigations have therefore been carried out over the last 10 years in order to understand the causes of problems and defects and these now provide a unique and extensive body of knowledge about the condition of the house. Each investigative report is reproduced in the Appendices of this report for ease of reference. Those most relevant to understanding the current condition of the external fabric are:

- **1998 NTS Quinquennial Survey**
- **2003 CMC Thermographic Survey**
- **2010 - 2021 HES thermography and moisture monitoring reports.**
- **2012 Quinquennial Fabric Condition Survey and Materials Analysis Reports**
- **2016 Quinquennial Fabric Condition Survey Update and subsequent inspection in 2021**
- **2016 – 2020 Annual environmental monitoring reports prepared by Sustainable Heritage Conservation.**
- **2018 Hutton + Rostron Rot Survey**
- **2018 - 21 HES 3D laser scan survey of the building.**
- **2021 NTS Interiors Authenticity Report**

These investigations, prepared by different conservation and technical experts using different tools and approaches, provide a range of knowledge about the fabric and its condition:

- The Quinquennial Fabric Condition Surveys, primarily visual and non-intrusive inspections, provide a record of how the external fabric of the house is deteriorating and the obvious signs of water ingress.
- The materials analysis carried out in 2012 provides an overview of the materials used in the construction of the house and a scientific analysis of the mechanism that is causing water ingress.
- The on-going HES thermography and moisture monitoring analysis coupled with the laser scan survey, being used for the first time together for such a purpose, delivers a three-dimensional visualisation of what is happening below the surface of the fabric without resort to damaging and intrusive physical interventions.
- The Environmental monitoring reports record how the internal environment of the house has improved in recent years due to the installation of widespread conservation heating and the erection of the protective Box.

The Introduction to the 1998 Quinquennial Survey states that:

"…The external walls still give cause for concern and will need to be kept under close observation during the next five years to monitor moisture content and efflorescence, subflorescence and contour scaling."

This is despite the extensive repairs carried out in the mid-1980s and early-1990s. In 2003, when thermography was used for the first time, it was clear that there were extensive areas of debonded render and that *"…the render will continue to degrade under the effects of thermal and moisture movement, frost action and, where appropriate, frost action."*

A programme of repairs was instigated but by 2012 the situation had deteriorated much further. The Introduction of the 2012 Quinquennial Survey states that:

"…Problems of water penetration have reached new levels, and bring with them continuing risks of dry rot outbreaks affecting the internal fabric of the house. Under extreme weather conditions of driving rain, the external walls fail to hold out the water which runs freely through the core."

The Introduction of the 2016 Quinquennial Report Update states that:

"Evidence within the solum and other areas of powdered and saturated brick and stone from the internal face of external walls suggests the core of the walls is continuing to hold water and that loose stone and brick may be falling on to horizontal timber wall linings and forming wet bridges between the external walls and the wall linings. This suggests that rot may be more widespread than currently visible."

Also:

"The roughcast of external walls appears to be crazed with cracks. There appear to have been a number of attempts to paint over fine cracks and to repair larger cracks with mastic but these attempts do not appear to have been successful.

Many junctions between the roughcast walls and other materials including lead appear to be cracked and be potential sources of water ingress."

The subsequent thermographic and moisture monitoring surveys by HES demonstrate the extensive nature of water ingress and the paths it follows through the core of the external walls.

When read together, the investigative reports are remarkably consistent in terms of their conclusions about the problems identified and their underlying causes. They describe a condition which has continued to deteriorate and a situation where the embedded moisture content of the external walls

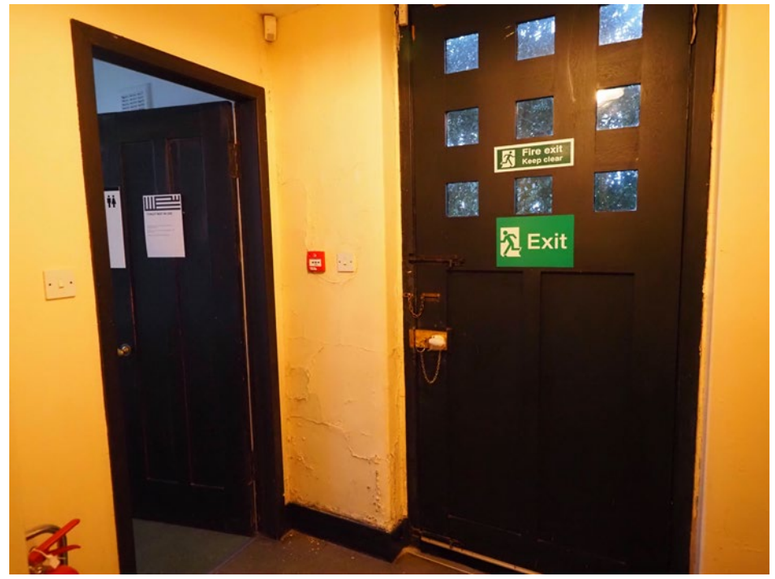
Water ingress and staining above Bay Window of Drawing Room

Water ingress and Damage in Library

Water ingress and damage, including rot, in Guest Bedroom Dressing Room

Water ingress and staining in stair tower

Water ingress and damage around windows



Rising Damp

is now so high that the brick, stone and bedding mortar forming the walls can no longer regulate the flow of moisture and are in some areas *dissolving*: placing the interiors and collections at high risk of damage.

The reports also create an evidence-based reference point against which to measure the success of possible future interventions. They also demonstrate that, until the erection of the protective Box, the external fabric of the house was suffering badly from water ingress, principally through defective wallheads; chimney flues; and cracks in the roughcast of the external walls but also from ground water and rising damp. The full extent of damage to underlying fabric is still unknown but there is visual evidence of on-going dampness and rot in a number of places including:

- the solum generally
- the boiler room
- the entrance porch
- above the entrance door where the soffit has collapsed
- rising damp in the cloakroom
- along the west wall of the Library, particularly at the fireplace window and the fireplace itself
- the bay window of the Drawing Room
- the East and South walls of the Dining Room
- rising damp within the Service Wing generally
- the South East corner of the First Floor Exhibition Room
- around the door and window in the Interpretation Room
- the Day Nursery
- various upper levels of the turnpike stair leading to the holiday accommodation
- South walls of holiday accommodation bedrooms
- North wall of holiday accommodation sitting room
- Attic areas

External Walls

The cement roughcast of external walls is crazed with cracks and some sections appear to have delaminated from their backing substrate. There appear to have been a number of attempts to paint over fine cracks and to repair larger cracks with mastic but these attempts have not been successful in keeping water out.

The cement roughcast over wallheads appears cracked generally and is undoubtedly allowing water to penetrate.

Many junctions between the roughcast walls and other materials including lead appear to be cracked and are potential sources of water ingress.

The base of many walls is damp as a result of rising damp.

There is evidence within the solum and other areas of decomposed brick, stone and bedding mortar from the internal face of external walls which suggests that the materials forming the core of the external walls are decomposing as a result of saturation. The extent of this problem is unknown but the HES moisture monitoring and thermography analysis has identified many areas of wall that have high moisture content which gives grounds for concern.

The HES analysis concludes that, due to the impervious nature of the roughcast, the moisture retained in the core of the external walls is drying out slowly towards the interior of the house rather than to the outside, with the increased risk of fabric damage that this process entails. The process of drying out is also slower than might be expected due to the impervious nature of the roughcast which is stopping water moving to the external surface of the roughcast and evaporating off.

The HES analysis also provides evidence that decomposing and loose stone and brick is likely to be falling on to horizontal timber wall linings, forming wet bridges between the external walls and the wall linings. The condition of the materials in the core of the external walls may in some areas have deteriorated to such a degree that they have lost their structural and technical integrity and may have to be replaced. Fabric rot may therefore also be more widespread than currently visible.

The problem of water ingress through the external fabric is an endemic one that has been present since the house was first completed and is a consequence of the nature and technical performance of the cement roughcast coupled with Mackintosh's omission of traditional weathering details on the basis of his misplaced confidence in the performance of Portland Cement as a water-proofing material. The roughcast is, in principle, impervious but as soon as cracks form as a result of thermal movement within the roughcast and substrates below or through differential movement between different materials, rain-bourne water penetrates the cracks and is trapped behind the roughcast, causing fabric deterioration.

Successive generations have tried to solve the problems of water ingress. Repair strategies in the past have ranged from wholesale replacement of original fabric to conservation and consolidation, reflecting the best conservation knowledge and principles of their time, and most have resulted in temporary success. Problems have always returned however with the risk of further collateral damage. In some instances, the repairs have replaced original fabric with new and in others the repair processes and materials may have caused significantly more damage than the problems they were intended to solve.

A future repair strategy must have the retention of the Significance and Authenticity of The Hill House at its heart. The unintended impacts of past repair strategies must also be understood in order not to repeat them. The surveys carried out by HES, co-ordinated with visual survey work, should be used to assess the effectiveness of past repairs and identify areas for further intrusive survey work that will develop our understanding of the condition of the brick, stone and mortar substrates underlying the roughcast.

National Trust for Scotland
Hill House, Helensburgh
Infrared Survey

CMC

M/1314/11/R1

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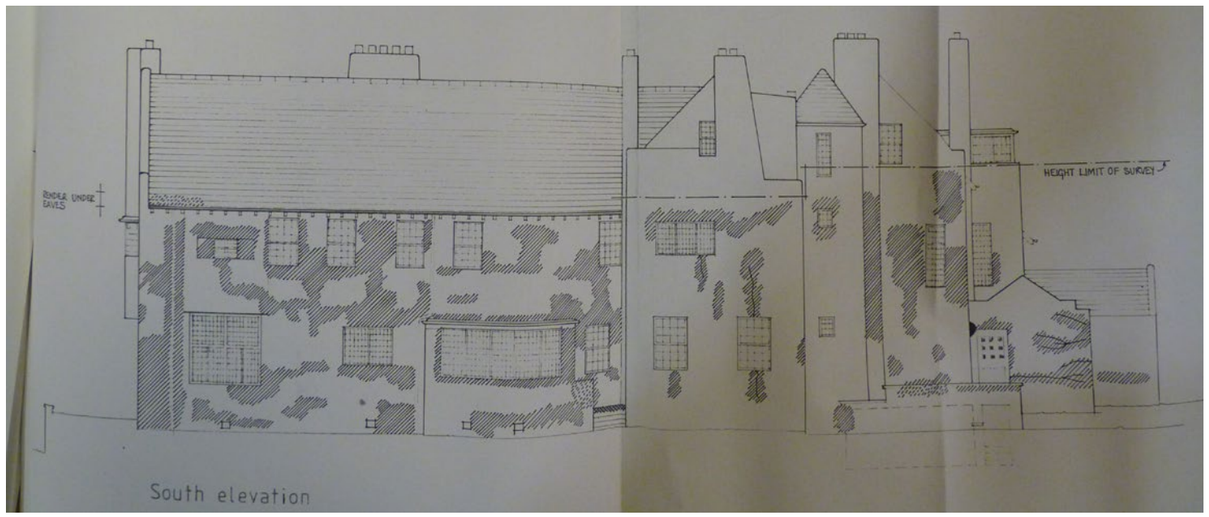
CMC Moisture Survey 2012

HES Moisture Survey 2019



Page and Park Render Survey c1989

LDN Survey 2016

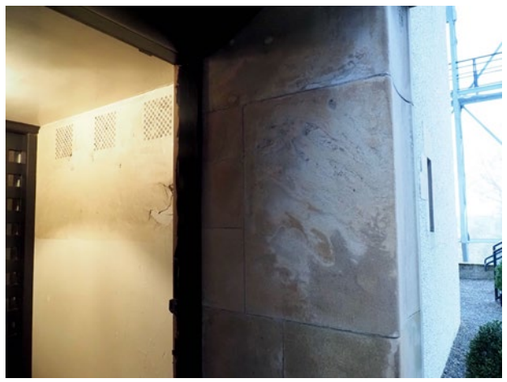
South Gable, 2016

South Gable, 2021

Evidence of roughcast deterioration has become much more visible since 2016 as a result of the Box preventing rainwater washing the elevations. As a consequence dirt and growths are accumulating and breaking down the paint surface highlighting cracks and staining. Different colours of paint can also be seen.

Decorative Stonework

There is relatively little exposed decorative stonework on the exterior of The Hill House. The exposed stonework around the entrance door has deteriorated badly however as a result of water ingress. The poor condition of the stone is a consequence of water saturation and is visible evidence of how poor the hidden stone substrates may be in other areas. Further investigation is required to develop an understanding of its condition and conservation needs.



Stonework around entrance showing signs of delamination and efflorescence as a result of being saturated

Roofs & Chimneys

The roofs were re-slated in the latter 20th century and many of the lead flashings replaced at the same time. A breathable underslating felt was also installed at this time but it has not been dressed into gutters and its general condition is unknown. The chases for leadwork cut into roughcast and stonework have generally been pointed using cement and many are cracked and are possible sources of water ingress.

Many of the concrete ridge tiles which were installed in the latter 20th century appear cracked however there is little evidence of water ingress in accessible attic areas.

There have been attempts to fit lead caps on a number of chimney cans but it is unclear how successful this work has been and also unclear how well the chimney flues are ventilated. Many of the chimney cans appear cracked and most of the cement haunching around chimney heads is cracked or spalling. Rain water and snow melt can run down the flue ways and penetrate the masonry liners. A number of chimneys have also been blocked at the throat of the flue behind the fireplace. This was probably carried out to reduce heat loss but has also completely cut off ventilation of the flue way and therefore reduced the ability of moisture to dry out within the masonry flue. The HES Reports suggest that the chimney flues are principal moisture conduits within the fabric.

The completion of the Box has stopped direct rainwater ingress to the flues so the lead caps covering many of the cans should now be removed to allow each flue to ventilate properly which will assist the fabric drying out process. Each flue should also be checked for blockages which should be removed. Controllable vents should be installed at the base of each and consideration also given to the introduction of mechanical ventilation.

Windows

Many of the windows facing the prevailing weather appear to be letting in water during inclement weather. External cills which were repaired in the 1990s appear generally sound however and there was little visual evidence of dampness internally below windows.

Ground

The site slopes generally downward from north to south. Along the north elevation, door thresholds are more or less at ground level but along the south elevation there is a substantial difference between floor level and ground level and a correspondingly higher under floor solum void. The ventilation of this solum is predominantly single sided on the south due to this topography, and there is no cross ventilation of the solum space as a result. Cross-ventilation should be installed to assist the fabric drying out process.

The ground has been observed to be saturated with water on the north side of the house and it has been reported that rainwater tends to run down the generally southward sloping grounds at the north of the house and lie in this area. It is likely therefore that there is hydraulic pressure on the north side of the house resulting in ground water being forced into the solum space and causing rising damp. As part of the work to construct the Box, alterations to ground and surface water drainage were undertaken and an interception drain was installed along the north side of the house.

Solum showing piles of decomposed stone and brick from the external walls. Crumbling brick and stone behind internal wall finishes is likely to be forming wet bridges

Roughcast on chimneys is cracked generally

Moss growth and capped flues

Cracked wallhead weathering and flashings

Chimney roughcast spalling

Box

A key conclusion of the 2016 Quinquennial update survey was that temporary protection should be erected around the most exposed and saturated sections of the external walls in order to prevent further water ingress and to allow building fabric to dry out. The construction of the protective Box around The Hill House in 2018 addressed these objectives in an imaginative and comprehensive way. Its metal roof prevents vertical rain hitting the building whilst its "chainmail" woven mesh walls stop much of the wind driven rain whilst permitting good natural ventilation. The chainmail is not entirely weather-tight however and, as a result of the extreme exposure of the site, sections of roofs, wallheads and walls do still become saturated during bad weather, depending on rain intensity and wind direction and strength.

The successful impact of the Box is demonstrated by reductions in fabric moisture content levels documented in the HES moisture monitoring and thermography reports of 2020 and 2021 compared with those in 2018 prior to the erection of the Box. Some areas of wall however do appear to be drying at a slower rate than others or not drying out at all. This is possibly related to those exposed sections of wall that are affected by wind driven water ingress during bad weather and requires further investigation. it may also be due to differences in roughcast materials which perform differently. this requires further investigations.

There is also some evidence that, due impervious nature of the roughcast and the Box which is also providing solar shade, moisture is drying out towards the interior of the building rather than to the external face of the building.

One negative consequence of the Box is that the external surfaces of The Hill House are becoming dirty as a result of air-borne deposits which are not washed off by regular rainfall. There is also some evidence that organic growths are flourishing in cracks and crevices in the roughcast and on ledges around the building.

The Box creates the opportunity to improve ventilation of the external fabric further and improve drying out, perhaps by removing sections of roughcast and the opening up of chimney flues, without the risk of major water ingress.

The Box should allow chimney caps should be removed to improve ventilation and drying out of fabric

The Box is not fully weather tight and exposed elements of the house continue to be soaked depending on prevailing weather direction

Dryness within Box and build up of dirt are highlighting cracked roughcast and other defects

Internal Environment

The Internal Environmental Monitoring reports for 2017, 2018 and 2020 demonstrate there was a marked deterioration in the conditions in 2017 when compared with 2016 with fewer areas recorded as achieving an 'acceptable' or 'ideal' standard of temperature and RH but the reasons for this are not clear. In 2018 the position recovered and broadly the pattern was similar to 2016. There are no records for 2019 but the records for 2020 show a remarkable improvement in the conditions. Most areas are now classed as 'ideal' and only one area is 'unacceptable'. This change is likely a result of improvements to the extent of the conservation heating system within the house and is also likely to be attributable in part to the environmental conditions created by the Box. There is no monitoring of the environmental conditions within the Box so its impact is not currently measurable. Consideration should be given to monitoring the environment within the Box and externally as benchmarks against which to measure improvements to the internal environment.

Current evidence suggests that if the fabric can be improved to keep the moisture out or if the Box remains in position then it appears that conservation heating can maintain good conditions within the house.

The Scottish Wall Paintings Conservator Report on the Condition of Painted Decoration (2020) and NTS Interiors: Authenticity Report (2021) both describe the current condition of internal finishes within the house and express concern about deterioration thought to be caused by the speed and extent of drying out since the erection of the Box. Many of the delicate decorative finishes are on external walls at the interface between the interior and exterior. Their condition needs to be monitored and the drying out process managed to prevent consequential unintended damage to authentic fabric.

Heating Systems

The heating systems in the house are based on either LTHW (low temperature hot water) radiators or electrical conservation heaters. The existing LTHW distribution system is of historical value and should be retained. It appears to function reasonably well in terms of its ability to emit heat, and so subject to further more detailed investigation it appears that it may be utilised as part of a conservation heating system. The individual heat emitters would however require to be fitted with control valves linked to a conservation heating control system.

Other areas of the house are heated by electric heaters under control of the Hanwell conservation heating control system. This installation has been carried out on a temporary basis however. A permanent arrangement with dedicated electrical supplies should be considered as part of the strategy to conserve the house. This heating system should also extend to the second floor accommodation.

The existing gas boiler has a limited operational life-expectancy of around 5-10 years before it requires replacement. Consideration should be given however to replacing it with an electric heating solution under conservation heating control which is the better option environmentally.

102 *White Bedroom*

Insulation

The house is essentially uninsulated. The lack of insulation may in this building be an advantage in terms of the external fabric. The external fabric being warmer due to heat loss is one of the mechanisms that will help keep the fabric drier. It is of course not the most cost effective or efficient way to keep the fabric dry, however the priorities are different in important buildings such as this and it may be that energy has to be used to preserve fabric in ways that in other circumstances would be considered ill-advised. Set against this, it does nevertheless appear possible to take some steps to improve the insulation that, if executed carefully, would benefit the operating costs of the heating. It does not appear as though the walls could be improved, nor should they be if this would interfere with the drying mechanism described above. The windows likewise would be very difficult to improve without significant impact on the appearance. There does however appear to be some scope for improving the roof and the suspended floor. It would require more investigation, but based on what we know of the construction it would be possible to introduce insulation in the roof space by insulating in the conventional way at ceiling level, and to the suspended timber floors by putting insulation between the joists and supporting it on netting or similar. These interventions would only be possible if good levels of ventilation can be provided to the roof space and the solum space to avoid increased risk of condensation.

Contaminated Materials

A contaminated materials survey of the house does exist but it does not cover all areas, for instance the solum. A new survey should be commissioned to cover all accessible areas.

Structure

There are no obvious indications of any significant distress to the main structure of the building. However, water ingress into the fabric of the building has been a long-term and continual problem. There is evidence that repair or replacement of secondary structural elements like bessemer beams and lintels may be required.

Some of the secondary structural elements like lintels are steel. The condition of these elements was seen to be suspect in some instances but the construction of the Box will have allowed the rate of deterioration of these elements to slow if not stop altogether.

Following construction of The Box, and now that the building and in particular its external walls are drying out, concern about the state of the embedded timberwork is heightened as moisture levels pass through a band in which the risk of dry-rot outbreaks is higher.

Climate

As a result of the severe exposure of the site and its coastal setting, it is rare that rain drops vertically on to The Hill House. Rather, salt-laden rain is driven into the building obliquely by the prevailing wind. This is apparent during bad weather even with the Box in place. Rainfall is rising in quantity, duration and intensity as a result of climate change and this problem needs to be addressed in the development of a conservation strategy.

Moisture Content Analysis

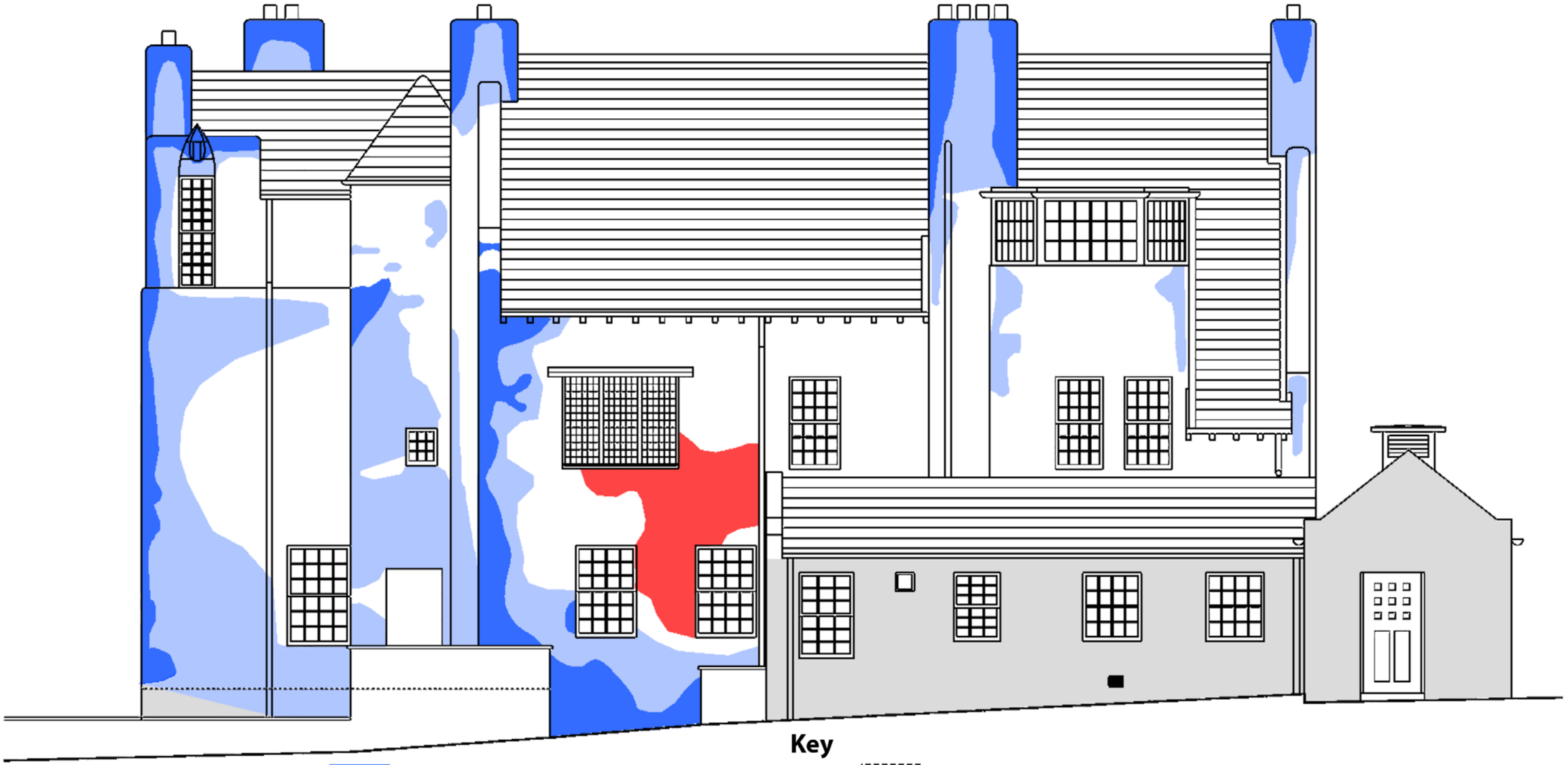
The following analytical drawings, prepared by Historic Environment Scotland, describe the extent of moisture ingress based on their 2019 Thermographic Survey. Detailed analysis of their 2021 survey is awaited but raw information suggests that, since completion of the Box, the external fabric is drying out but at varying rates. Moisture is however being trapped behind impervious roughcast and, in consequence, the fabric is generally drying out towards the interior of the house rather than its outside. Significant moisture reservoirs remain within the substrate of the external walls.

The analysis demonstrates extensive saturation at virtually every wallhead where the weather proofing of the roughcast has broken down and at exposed corners of the building. The extent of water penetration appears to be worst on the South and West elevations of the house which face the prevailing weather. It would also appear that once moisture is behind the roughcast it tracks horizontally as well as vertically, perhaps following cracks and voids. Arguably, the North East gable, repaired by Boys Jarvis in the 1980s, appears to be performing better than other areas but this may also be because it is less exposed to the prevailing weather.

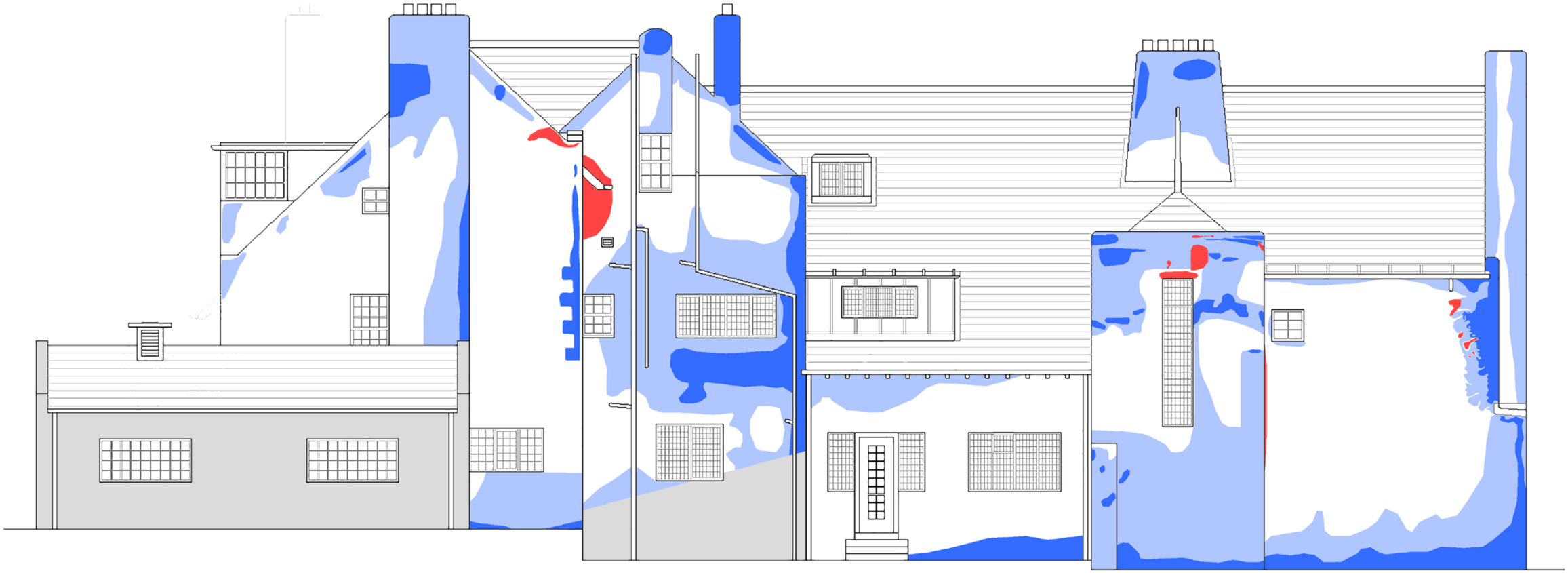
The chimneys, irrespective of age, all appear to be saturated at high level and to be ducting moisture through their flues to lower areas of the fabric.

A notable difference between the 2019 survey and previous surveys is the degree to which the fabric is saturated at ground level, possibly as a result of rising damp.

It can also be seen that the exposed stone around the Front Door on the west elevation is being damaged by moisture dropping from above and rising from below. There is thought to be a large area of detached render above the Drawing Room Bay Window and it is possible that this is the cause of the water ingress and staining in the drawing Room below, rather than the weather flashing between the Bay Window flat roof and main wall.



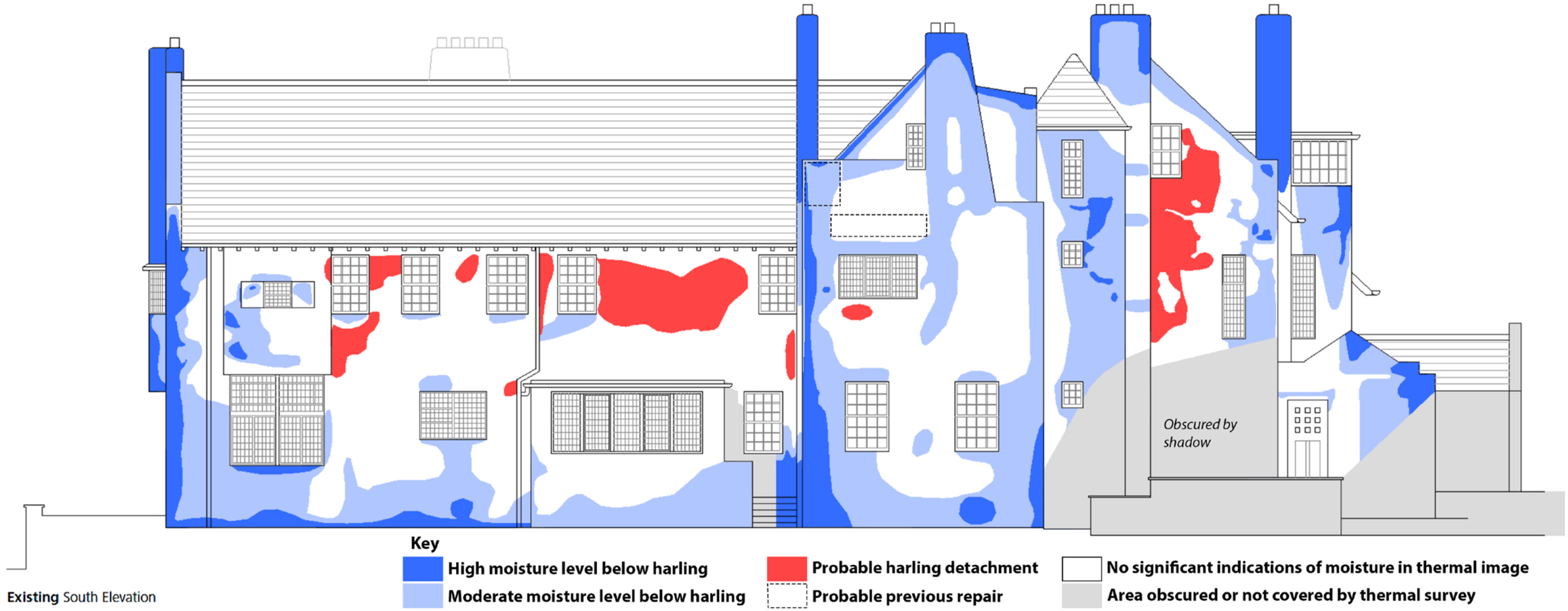
Existing East Elevation



Key

- High moisture level below harling
- Moderate moisture level below harling
- Probable harling detachment
- Probable previous repair
- No significant indications of moisture in thermal image
- Area obscured or not covered by thermal survey

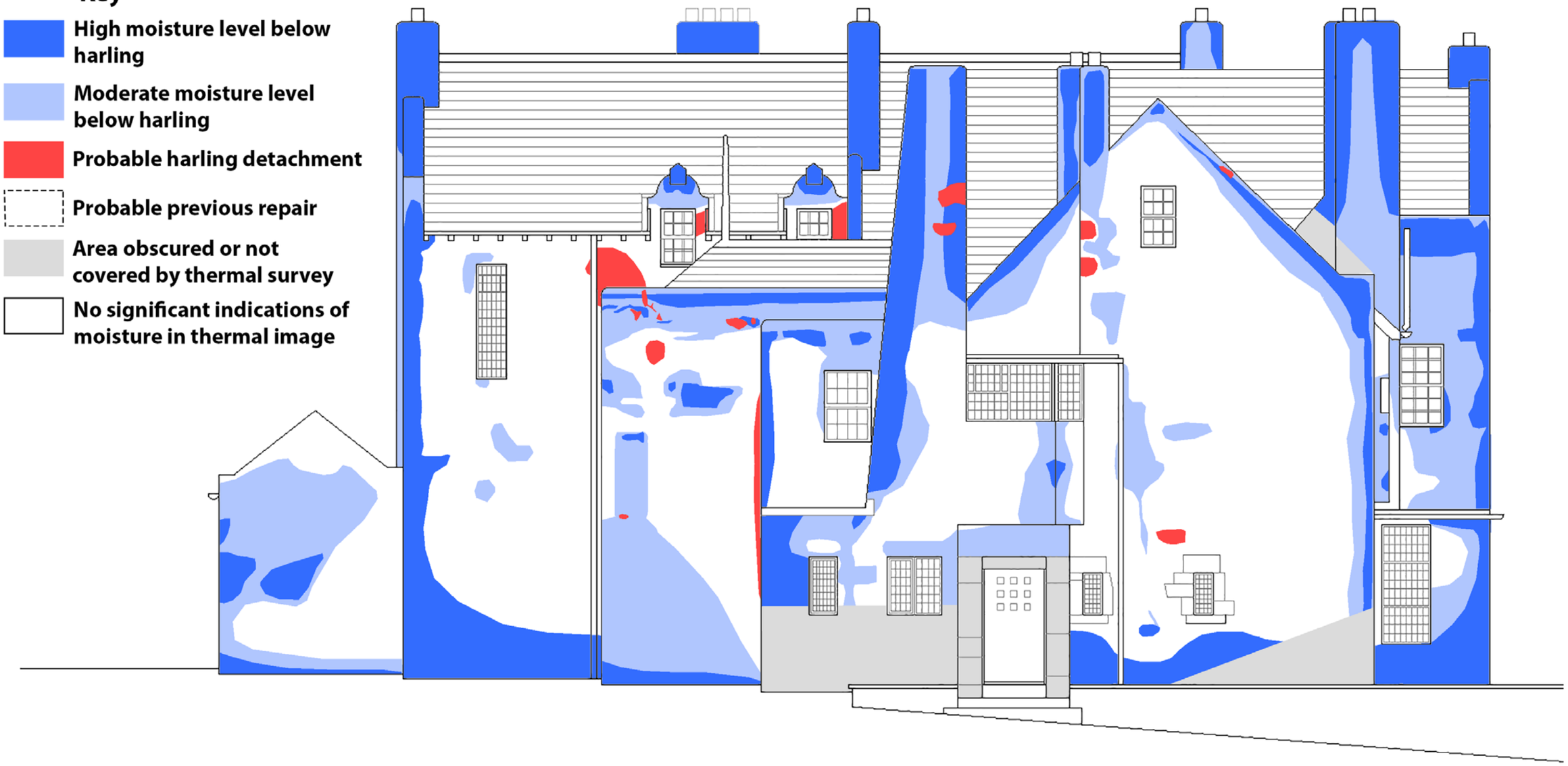
Existing North Elevation



Existing South Elevation

Key

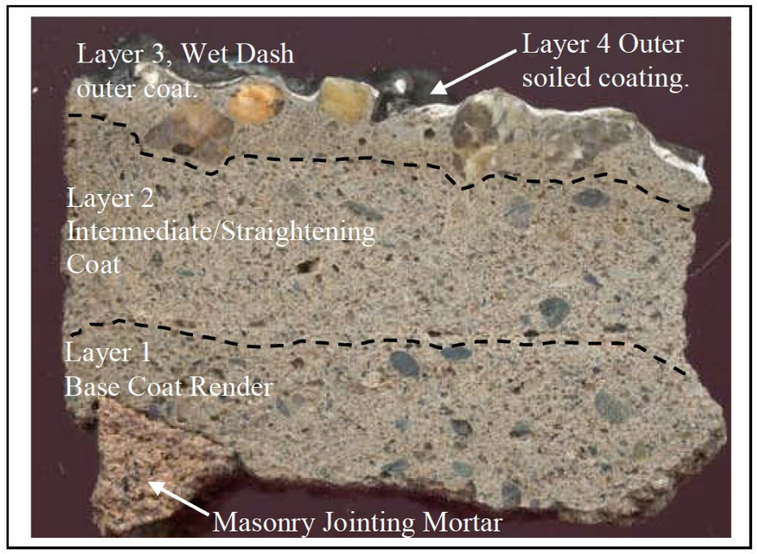
- High moisture level below harling
- Moderate moisture level below harling
- Probable harling detachment
- Probable previous repair
- Area obscured or not covered by thermal survey
- No significant indications of moisture in thermal image



Existing West Elevation

10.0

Conservation Strategy



CMC Roughcast section 2012

Plate No. 3:

Mortar Sample S1 with the boundary between the various coats highlighted by broken lines superimposed onto the plate.

Powdered brick and stone at base of external walls in solum, 2021

Remains of saturated and decomposed brick in East Gable of Attic, 2021

First Floor wall ventilator. Powdered brick / stone dust can be seen blown out on to carpet, 2021

Conservation Strategy

The evidence of the technical investigations and survey work to date, described in Section 9, is that the condition of the external fabric of the house continued to worsen as a result of water ingress until the construction of the Box in 2018. At that time, the embedded moisture content of the external walls was so high that the building materials forming the walls could no longer regulate the flow of moisture and were in some areas *dissolving*: placing the interiors and collections at high risk of damage. The principal causes of water ingress were:

- defective cement roughcast over wallheads
- cracks in the cement roughcast of the external walls
- defective leadwork flashings and other weathering details
- open chimney flues providing moisture pathways through the fabric
- groundwater causing rising damp along the rear elevations of the house

The objective of this Research and Development project is to describe a conservation planning process by which long-term solutions for the problems of water ingress can be identified and implemented without detriment to the Significance and Authenticity of Mackintosh's design. Such solutions will therefore be dependent on:

- An agreed understanding of the property's Significance & Authenticity;
- A detailed technical, evidence based, understanding of the external fabric condition and its impact on the condition of interiors and collections;
- Identification of an alternative material to the Portland Cement roughcast, originally used as the external wall finish, that actually works to keep water out in the way intended.
- Improvement of the weatherproofing details particularly at wallheads and chimneys in ways that prevent water ingress whilst restoring the Authenticity of Mackintosh's original design.

The British Geological Survey Report, forming an appendix to the 2012 Quinquennial Survey, describes succinctly the mechanism of water ingress and decay:

1. *Water penetrates the mortar through cracks and finds a main path of penetration between layers 3 and 4 [of the roughcast]*
2. *This water influx saturates the base coat which is more porous and permeable, allowing access of the water to the brick and sandstone substrate.*
3. *This trapped water never gets fully evaporated as layers 2 and 3 are of lower permeability, the water circulating towards the building instead of drying out of it.*

The defective cement roughcast allows water ingress through cracks which then, due to the impervious nature of the roughcast generally, gets trapped within the core of the wall and "wicks" through to the inner face of the walls. This water ingress is causing on-going deterioration of the stone and brick core of the external walls which in turn is creating wet bridges to internal linings and pathways for rot. Whilst the Box now prevents most water ingress, the HES moisture monitoring surveys demonstrate that moisture levels within the core of the external walls are still high and that the building is drying out to the inside rather than outside. The full extent of deterioration behind wall finishes is unknown as is the durability of the brick and stone forming the core of the walls.

Numerous attempts over the life of the house have been made to cure the problem of water ingress and these are summarised in Section 7 of this report and in Wright's Condition and Authenticity Report (2012). These repairs, ranging from wholesale replacement of fabric to conservation and consolidation, reflect the best conservation knowledge and principles of their time and most have resulted in temporary success. Problems have always returned however with the risk of further collateral damage. In some instances, the repairs have replaced original fabric with new and in others the repair processes and materials may have caused significantly more damage than the problems they were intended to solve. Early approaches attempted to solve the problems by the removal of original fabric and alterations to improve weathering details which changed the character and form of the house. Arguably, the most successful repairs, technically, were the Boys Jarvis repairs of the 1980s. These were however particularly invasive and resulted in a considerable loss of original fabric. The Page & Park repairs of the 1990s were the subject of intense debate and the emphasis at that time was on the retention of existing fabric.

Change is inevitable and since the 1990s, the principle of defining and protecting *Authenticity*, rather than simply retaining existing fabric, has become more widely understood and supported. This emphasis is reflected in the conclusions of the Conservation Principles published by English Heritage in 2008:

> *Retaining the authenticity of a place is not always achieved by retaining as much of the existing fabric as is technically possible.*

The NTS Conservation and Vision Statement prepared in 2011 endorses this approach and states that:

> *The Mackintosh design is of the highest significance and that the authenticity of the fabric externally is secondary, consequently the Trust's main priority will be to ensure that the design aesthetic is always preserved, even if this means potentially compromising older fabric and finishes externally.*

The ICOMOS Madrid – New Delhi Document (2017) defines *Authenticty* as:

> *…the ability of a heritage place or site to express its cultural significance through its material attributes and intangible values in a truthful and credible manner. It depends on the type of cultural heritage place and its cultural context.*

The Madrid – New Delhi Document also places *Authenticity* in context and states that:

> *The cultural significance of a place or site as historic testimony is principally based on its original or significant material attributes and / or its intangible values, which define its authenticity. However, the cultural significance of an original heritage place or site, or later interventions, additions, landscape elements or new elements, does not depend on their age alone. Later changes that have acquired their own cultural significance should be recognised and respected when making conservation or development decisions…. (Article 9.2)*

The aim of this Research and Development project is therefore to describe a methodology by which a long-term solution can be developed to solve the problems suffered by the external fabric of the building whilst protecting the *Authenticity* of Mackintosh's design. In this context, "Authenticity" and "Mackintosh's design" relate not just to the external design of the house but to other aspects including its interiors, collections and setting as a whole. Conservation decisions about the external fabric will inevitably have direct and indirect impacts on these other aspects and will have to be made holistically.

Work on the project to date, including the construction of the protective Box, broadly follows the processes set out in the Burra Charter and 2017 Madrid - New Delhi Document which describes the *Approaches to the Conservation of Twentieth Century Cultural Heritage* as follows:

Develop Knowledge and Understanding about Cultural Significance

Implement Conservation Planning Process

Research Modern Materiality and Physical Planning

Manage to Sustain Cultural Significance

Manage for Environmental Sustainability

Interpret, Communicate and Build Capacity

A great deal is now known about the Significance of The Hill House and the factors and issues affecting it, including the causes of water ingress and the problems caused by it. In the medium term it is essential to retain the Box until the external fabric of the building has dried out. Thereafter, on the basis of current knowledge, there are four potential conservation strategies for the external fabric of the house. These strategies depend on the condition of the existing wall fabric and whether or not a new roughcast material can be identified to solve the problems of water ingress. Each has different impacts on the significance, authenticity and future maintenance and operation of the property which are still to be investigated:

1. The protective Enclosure is removed and the external fabric conserved as existing using modern Portland Cement alternative.
2. The protective Enclosure is removed and the external fabric restored to its original design using modern Portland Cement alternative.
3. The house is permanently contained within a protective Enclosure and the external fabric is conserved as existing.
4. The house is permanently contained within a protective Enclosure and the external fabric restored to its original design using a Portland Cement based material matching the original specification.

All conservation strategies require comprehensive monitoring and maintenance procedures to be put in place to identify and address water ingress before it become serious enough to create problems.

There are still however knowledge gaps which need to be closed before a preferred Conservation Strategy can be identified and Conservation and Maintenance Policies developed to support it.

In terms of the original Mackintosh design, there is documentary evidence of how The Hill House appeared when first completed; notably the 1904 article by Angeloti in *Deutsche Kunst und Dekoration* with accompanying Bedford Lemere photographs. These photographs, which were perhaps edited to suit the article's intended international audience, have to be treated with caution due to the contrived image of the house they convey *(Ref Wright (2012), p 36).* The Bedford Lemere photographs, together with subsequent photographs by RCAHMS and others do however allow a comparison to be made of the original as-built design with what has changed, how often, and what now exists. Original fabric including brick and stone has been altered or removed, particularly at wallhead level and above, and weathering details, including the profile of wallheads, have changed. The analytical drawings on pages 71-74 of this report describe the extent of these changes based on evidence uncovered to date.

Further detailed archival research and analysis is required to document The Hill House as first completed by Mackintosh and what makes it Significant, including its Authenticity. Establish the limits of acceptable change.

The use of Portland cement roughcast by Mackintosh is itself of significance, both as an example in use of a new 20th century material and for the way in which he used it to remove the need for traditional weathering details. Surviving elements of original roughcast are therefore important in terms of *Authenticity*; even more so now in the context of the catastrophic loss of original Mackintosh work as a consequence of the Glasgow School of Art fires. The need to retain this original fabric is however potentially in conflict with the need to deliver a long-term technical solution that prevents water ingress and consequent fabric damage.

Further survey work is required to identify conclusively the extent and location of surviving original roughcast.

The long-term retention of the *temporary* Box is a potential solution to the problem of water ingress. It prevents most water ingress and protects surviving fabric. It also provides visitors with a unique experience of Mackintosh's design. In theory, making the Box permanent would enable the house to be conserved as it is now or restored to its original design using Portland cement without the risk of further water penetration. The Box, however, changes fundamentally the setting of the house. Intended relationships between the inside and outside of the house and between the house, garden and wider landscape are lost and, despite the visual transparency of the Box, the building becomes much less *a house for living in* and more a museum object within a display case. Fabric is protected but the *Authenticity* of Mackintosh's overall design intent is detrimentally undermined.

Further analysis is required to explore the impacts of the Box on an agreed definition of Authenticity.

The extent of work required to upgrade the Box, which has a limited life expectancy, to become a permanent enclosure together with associated costs and implications in terms of statutory approvals should be investigated.

If it is concluded that the retention of the Box is not a long-term solution because of its detrimental impact on *Authenticity*, the conservation options are either to conserve the external fabric as it exists now or to restore it to Mackintosh's original design on the basis of documentary evidence. The choice of approach will depend on which best protects the *Authenticity* of the design, including retention of original fabric.

Established conservation principles suggest that buildings should be repaired with "like for like" materials and that significant layers of change should be respected. The use of Portland cement as a roughcast material has however manifestly failed in its intended purpose and consequent damage to original fabric has been considerable. It is unlikely therefore that replacing the existing non-original roughcast with new Portland cement roughcast matching the original specification would be considered a rational long-term technical solution if the Box is removed.

In principle, the aims and ambition in relation to conserving 20th century architecture are no different to those relating to the conservation of earlier buildings. There is a general recognition however that the technical performance of the new construction materials of the 20th century were not fully understood when first used. Replacement with more modern alternative materials that provide better technical performance but achieve the same overall design aesthetic is therefore generally accepted as a conservation approach which addresses technical issues and protects the *Authenticity* of design intent.

At The Hill House, it is clear from design drawings, photographs and comparison with other Mackintosh projects that the significance of the Portland cement roughcast relates to the way it was used by Mackintosh to achieve a desired design aesthetic; made possible by its reputed waterproofing qualities. It is also reasonable to speculate that, if another material with better performance characteristics had been available to achieve the same effect, it is likely Mackintosh would have used it in preference to the Portland cement. The surviving original roughcast is therefore important in its own right as a material specified and applied to Mackintosh's requirements but its greater importance relates to the design aesthetic it made possible.

On the basis of current evidence, it appears almost all of the original cement roughcast has been replaced in the past and that very little remains to conserve. It is self-evident in terms of *Authenticity* that any remaining original roughcast should be conserved but it is also logical, given that almost all the current wall finishes are not original and not of sufficient significance in their own right to be protected, that an alternative, better performing, material should be used to repair the fabric and restore Mackintosh's original design intent. This new replacement material should be capable of replicating the aesthetic of Mackintosh's original roughcast but must also overcome the technical failures of the original Portland cement: it should be waterproof but also breathable, flexible and capable of being applied to the fragile brick and stone substrates without causing further long-term damage.

Technical reviews of comparator conservation projects are required to identify potential successful repair material. These comparator projects may relate to iconic 20th century buildings with similar material and condition issues but should also relate to those in similar exposed climates, including cement-rendered buildings in the Western Isles of Scotland.

Investigative work is required to identify what materials might now be available to replace the existing roughcast. This research should include both industry and academia. Key characteristics of the material will be that it is waterproof but breathable; thermally flexible; matches the original roughcast visually; long-lasting; and technically harmless to surviving original fabric.

Trials and samples of proposed new materials should be prepared and monitored to assess their performance and ensure that they do not result in unintended long-term detrimental consequences for the fabric of The Hill House as previous repair methodologies have done.

If it proves impossible to identify a new material as described above, it may be necessary to use a tried and tested material but adopt much more stringent monitoring systems and maintenance protocols to ensure that areas of moisture build-up are dealt with quickly before they cause further damage

The condition and long-term durability of much of the core of the external fabric is still unknown as it is hidden behind other materials. On the basis of the evidence provided by the HES surveys and previous sampling work by CMC (2012), however, there is a high probability that extensive sections are in a fragile condition as a result of long-term saturation.

Further investigative work is required to confirm the condition of hidden fabric, ie the core of external walls. This work should be correlated with a survey of the extent of previous repairs to understand which, if any, have been successful.

Investigative work is also required to identify whether existing, non-original, roughcast can be removed without unacceptable damage to substrates and also whether new roughcast can be applied without consequent damage.

As a result of the severe exposure of the site and its coastal setting, it is rare that rain drops vertically on to The Hill House. Rather, salt-laden rain is driven into the building obliquely by the prevailing wind. This is apparent during bad weather even with the Box in place. Rainfall is rising in quantity, duration and intensity as a result of climate change and this problem needs to be addressed.

Further research into the likely impacts of climate change at the site is required to assess whether Mackintosh's design can survive long-term or whether adaptions are required to accommodate worsening weather conditions.

Survey plans of The Hill House have been prepared over the years by different organisations including the NTS and RCAHMS. There is however no comprehensive and definitive set of measured survey drawings of the building. HES, working alongside the NTS, has carried out a high-resolution laser scan of the exterior and interior of the whole building but this now needs to be developed into a 3D model and 2D plans, sections and elevations that can be used consistently by all those working on the project. The 3D model itself has the potential to become a focus for the collation, analysis and sharing of information about the project.

The HES survey information should be used to prepare a 3D Building Information Model (BIM) meeting industry information standards and information protocols together with 2D plans, sections and elevations.

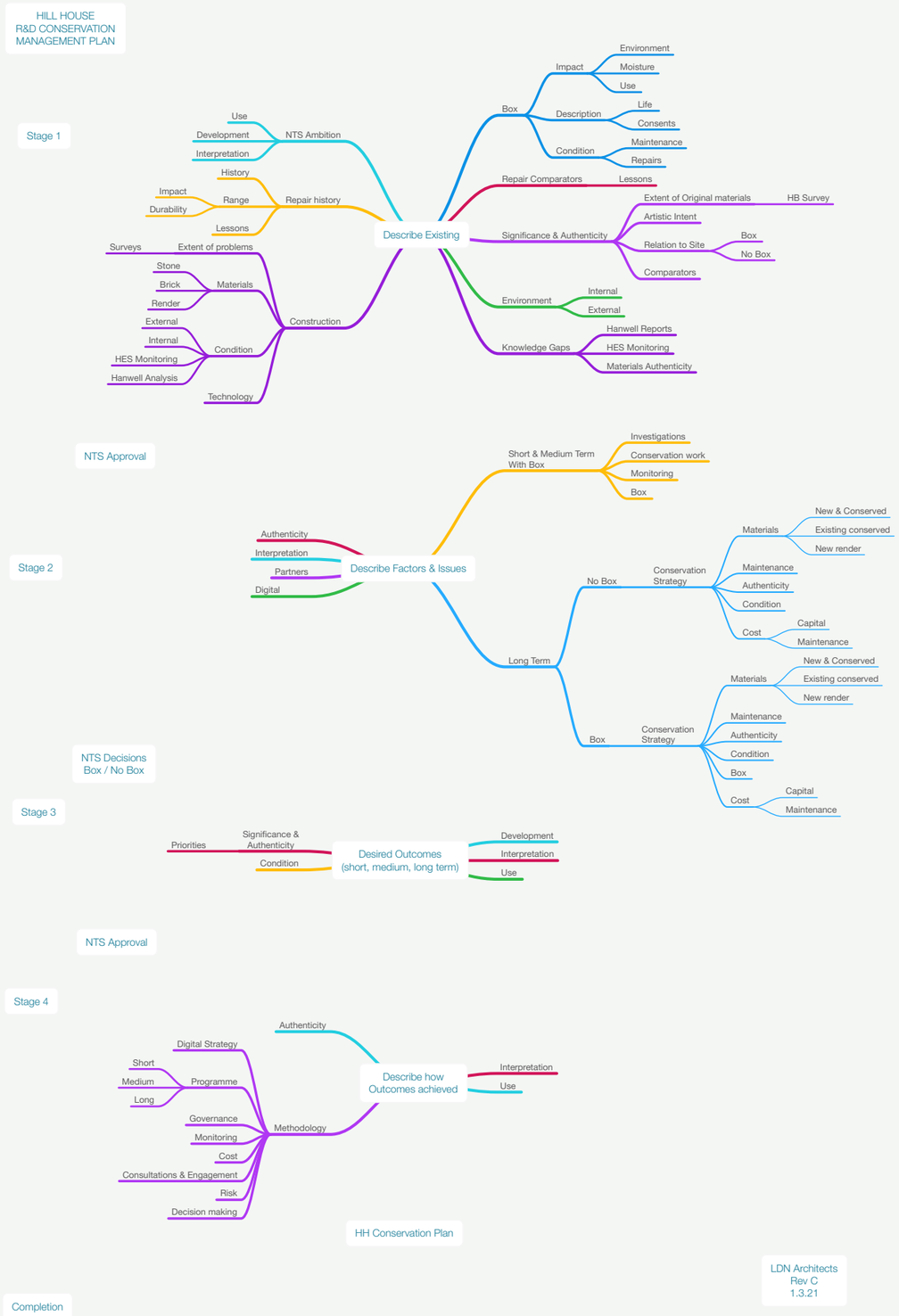
The following section of this Report describes the work required to address these knowledge gaps together with an anticipated project development and delivery programme.

HES / NTS Sketchfab online Digital Model
https://sketchfab.com/3d-models/hill-house-helensburgh-d83a09e1b66444c09a607e09bed508c5

HES / NTS Sketchfab online Digital Model
https://sketchfab.com/3d-models/hill-house-helensburgh-d83a09e1b66444c09a607e09bed508c5

11.0

Conservation Implementation Plan


HILL HOUSE
R&D CONSERVATION
MANAGEMENT PLAN
Stage 1
NTS Ambition
Use
Development
Interpretation
Repair history
History
Range
Impact
Durability
Lessons
Construction
Extent of problems
Surveys
Materials
Stone
Brick
Render
Condition
External
Internal
HES Monitoring
Hanwell Analysis
Technology
Describe Existing
Box
Impact
Environment
Moisture
Use
Description
Life
Consents
Condition
Maintenance
Repairs
Repair Comparators
Lessons
Significance & Authenticity
Extent of Original materials
HB Survey
Artistic Intent
Relation to Site
Box
No Box
Comparators
Environment
Internal
External
Knowledge Gaps
Hanwell Reports
HES Monitoring
Materials Authenticity
NTS Approval
Stage 2
Describe Factors & Issues
Authenticity
Interpretation
Partners
Digital
Short & Medium Term
With Box
Investigations
Conservation work
Monitoring
Box
Long Term
No Box
Conservation
Strategy
Materials
New & Conserved
Existing conserved
New render
Maintenance
Authenticity
Condition
Cost
Capital
Maintenance
Box
Conservation
Strategy
Materials
New & Conserved
Existing conserved
New render
Maintenance
Authenticity
Condition
Box
Cost
Capital
Maintenance
NTS Decisions
Box / No Box
Stage 3
Desired Outcomes
(short, medium, long term)
Priorities
Significance &
Authenticity
Condition
Development
Interpretation
Use
NTS Approval
Stage 4
Describe how
Outcomes achieved
Authenticity
Interpretation
Use
Methodology
Digital Strategy
Programme
Short
Medium
Long
Governance
Monitoring
Cost
Consultations & Engagement
Risk
Decision making
HH Conservation Plan
LDN Architects
Rev C
1.3.21
Completion

Conservation Implementation Plan

The following section describes the activities required to develop and implement a substantiated programme of conservation works in relation to the external fabric of the house. The activities are broken down into the following stages:

1.0 Work to Assist Drying Out

2.0 Essential Research and Investigations to Inform Decision-Making

3.0 Preparation of a Detailed Conservation Strategy

4.0 Preparation of a Conservation Implementation Plan

5.0 Conservation Delivery

6.0 Parallel Workstreams

1.0 Work to Assist Drying Out

Whilst the HES moisture monitoring surveys demonstrate that the fabric of the house is drying out, they also conclude that some areas are not drying out as fast as others and that the fabric still contains high levels of moisture. There are a number of actions that could be taken to enhance the drying out process.

		ACTION
1.1	Consider removing non-original roughcast to encourage drying out of building towards outside rather than to inside. This should only be done after completion of the surveys related to the roughcast identified in Section 2.0 below.	NTS
1.2	Remove chimney caps to allow better ventilation of flues.	NTS
1.3	Survey chimney flues and remove any obstructions.	NTS
1.4	Ensure fireplaces are ventilated.	NTS
1.5	Extend conservation heating system to areas not currently covered. Consider increasing set point to 65% RH to protect interior decorative finishes.	NTS
1.6	Northwest single-storey building is unprotected from water ingress during adverse weather. Install additional protection measures.	NTS
1.7	Repair leaks in roof of Box and install additional protection around elements of the fabric that are still exposed to wind driven rain. Prepare and implement a maintenance plan for the Box.	NTS
1.8	Install environmental monitoring system both within Box and outside to provide benchmarks against which to measure changes. External monitors should measure wind strength and direction as well as temperature, humidity and rainfall.	NTS
1.9	Install an environmental monitoring system in the external fabric in selected locations to record trends in water content.	NTS
1.10	Clean external fabric where dirt and vegetation are beginning to build-up. Wash down elevations regularly.	NTS
1.11	Clean out existing solum vents and install additional solum ventilation.	NTs
1.12	Monitor surface water drainage around the gardens to ensure no build-up which could affect solum. Consider upgrading ground drainage along the rear of house.	NTS
1.13	There is a risk of rot outbreaks as fabric dries out. Act on Hutton & Rostron recommendations and monitor visually for signs of mould growth. Consider further rot hound survey.	NTS
1.14	There is visible evidence that decorative stonework around the building is deteriorating as a result of water penetration and saturation and the exposed surfaces look fragile. The consequence is that original architectural detail is being lost. This is particularly obvious in the stonework around the front door and needs to be addressed to prevent further loss. Commission a Stone Conservator to prepare a condition survey of exposed decorative stone and implement conservation recommendations.	Specialist Consultant

2.0 Essential Research and Investigations to Inform Decision-Making

The focus of the Research & Development Project is on the authenticity, condition and performance of the external fabric but decisions about its future cannot be made in isolation. As an example, the NTS Interiors Authenticity Report provides, for the first time, an evidence-based assessment of how the interiors have been affected by water ingress and demonstrates how decisions about repairs to the exterior of the house can have a major impact on the interiors. There are therefore a number of Knowledge Gaps which need to be closed to ensure that decisions about conservation of the external fabric can be made on the basis of a full understanding of the issues:

2.1	Carry out further detailed archival research and analysis to document The Hill House as first completed by Mackintosh and what makes it Significant, including its Authenticity. Confirm, also, the extent of subsequent changes. The research should relate to the whole site, including interiors, collections, landscape, boundary walls, gates and ancillary buildings and not just changes to the external fabric.	Specialist Consultant
2.2	Carry out further survey work and documentary research to identify conclusively the extent and location of surviving original roughcast. This is likely to require a detailed visual survey of all elevations and possible chemical analysis of samples. It is possible that the HES hi-res scan of the building has sufficient detail to help identify different roughcast finishes.	Specialist Consultant
2.3	Prepare further analysis and explore the impacts of the Box on an agreed definition of Authenticity.	Specialist Consultant
2.4	Prepare technical reviews of comparator conservation projects to identify potential successful repair materials and processes. These reviews should cover buildings with similar fabric materials and issues and also those in similar severe climates, including cement-rendered buildings in the Western Isles of Scotland.	Specialist Consultant
2.5	Carry out research to identify what materials might now be available to replace the existing roughcast. This research should include both industry and academia.	Specialist Consultant
2.6	Update the Contaminated Materials Survey to ensure all areas of the site are covered.	Specialist Consultant
2.7	Carry out further investigative work to confirm the type and condition of hidden fabric behind wall linings. This work should be correlated with a survey of the extent of previous repairs to understand which, if any, have been successful. The work should be carried out using non-invasive techniques if possible (ie using borescopes) but may require opening up, sampling and analysis of hidden fabric and roughcast.	Specialist Consultant
2.8	Open up the fabric behind selected areas of repaired and replaced roughcast to survey the condition of the brick, stone and mortar substrates behind and the deep moisture content levels of the fabric. Assess the impact of each repair strategy. It is likely that a series of cores through the external fabric will be required to investigate and compare the condition and performance of materials in different parts of the building.	Specialist Consultant
2.9	Analyse samples of decomposed stone and brick for causes of decomposition.	Specialist Consultant
2.10	Carry out investigative work to identify whether existing, non-original, roughcast can be removed without unacceptable damage to substrates and also whether new roughcast can be applied and subsequently removed without consequent damage. This is likely to require the removal of non-original roughcast from trial areas and should be co-ordinated with the fabric condition analysis described under items 2.7 and 2.8.	Specialist Consultant
2.11	The HES point cloud survey information should be used to prepare a 3D Building Information Model (BIM) meeting industry information standards together with 2D plans, sections and elevations for use by the project team. Information ownership and sharing protocols to be agreed.	Specialist Consultant
2.12	The conclusions of the HES thermography and moisture-monitoring surveys should be reviewed. Problem areas should be identified and monitored against control areas. If relevant, problem areas should be opened up for inspection. Coordinate with Action 2.7	NTS
2.13	Monitor and record the internal environment of the Box and open external environment to provide a baseline for internal and fabric condition analysis and to monitor changes and impacts inside and outside the Box.	NTS
2.14	Carry out a Climate Change Risk and Impact Assessment for the property to assess the range of changes possibly required to ensure the building is protected from the impacts of climate change.	NTS / HES
2.15	Consider carrying out a full Quinquennial Survey of fabric condition.	NTS
2.16	This methodology relates to the repair of the external fabric. Prepare a comprehensive Statement of Significance and Conservation Plan for the property to ensure that no unintended consequences affecting the Significance and Authenticity of the property arise as a result of external fabric conservation work proposed.	NTS

2.17	The Hill House was originally heated by open fires but its internal environment is now regulated in a very different way using conservation heating. Carry out an options appraisal of the range of possible options for the future environmental control of the building and their potential impacts on the future management and Significance of the property.	NTS
2.18	Centralise information database and make available to project stakeholders. Establish information management and sharing protocols.	NTS
2.19	Consider whether statutory consents, principally Listed Building Consent, are required for any of the investigative and repair work noted and apply for any consents required prior to work commencing.	NTS
2.20	Carry out a study to determine how the Box will be removed and its capability for re-use in the future, including potential costs. Essential site remedial work to deal with the Box foundations and site drainage etc to be covered also.	NTS
2.21	The drying out of the external fabric is a consequence of the Box preventing rain penetrating the fabric of building. As the drying out process continues, the rate of drying out and its consequences should be monitored. Consideration should be given to whether periodic wetting of the external surfaces or other measures are required to manage the drying out process without detriment to the changing condition of the fabric.	

3.0 Preparation of a Detailed Conservation Strategy

On the basis of the information assembled to date and described in Section 2.0 above, define Short, Medium and Long-Term conservation objectives and a conservation strategy that delivers them for approval by project stakeholders.

The strategy will be predicated on whether or not the Box is retained in the long-term.

4.0 Preparation of a Conservation Implementation Plan

On the basis of the Strategy defined in Section 3.0 above, develop a brief and appoint a project team to develop a conservation implementation plan, including cost, programme and activities, which delivers the approved conservation objectives. Level of detail should be equivalent to RIBA Design Stage 3.

5.0 Conservation Delivery

Deliver the conservation work defined at RIBA Stage 3, through Stages 4 – 7.

6.0 Parallel Workstreams

Understanding The Hill House

The focus of the R&D project is to solve the problems of water-ingress but these problems cannot be solved in isolation as potential solutions may well have impacts on other aspects of the property including the condition of its original fragile decorative finishes and fittings. Equally, an assessment of the Authenticity of The Hill House will depend on developing an understanding of all aspects of its Significance including its interiors, collections and the landscape in which it was designed to sit. Proposals for the future use of the house, including visitor facilities, will also influence decisions.

A comprehensive Statement of Significance and Conservation Plan for the property should be developed to ensure that Heritage Impact Assessments can be developed and that there are no unintended consequences for the Authenticity of the property as a result of R&D project conservation proposals.

Engagement & Dissemination

This report is intended to describe the process by which a scope of conservation work in response to the problems of water ingress at The Hill House can be developed and implemented. At the heart of this process is the need to fully understand the range of problems and develop technical solutions that solve these problems without detriment to the Significance and Authenticity of The Hill House and without unintended long-term consequences. The process is not however just a technical one. The Hill House is of International Significance and the development of conservation proposals will be the subject of widespread scrutiny. The process must therefore engage and embrace as much diverse expertise and as many interested parties as possible; taking all on the journey in a collaborative manner rather than presenting a fait accompli which will then undoubtedly be open to challenge.

NTS Governance, Decision-Making & Communications

A project governance structure needs to be put in place to direct delivery of all aspects of the project within agreed timescales and budgets and to ensure that the range of expertise available within the organisation is fully engaged in the project. The structure might include the establishment of a steering group; an expert advisory committee; and a delivery team. An approvals process should also be put in place.

A Business Plan and Funding Strategy also need to be developed in parallel with technical conservation proposals.

Partnerships

To date, the project has benefited from successful partnerships with the Getty Foundation and Historic Environment Scotland amongst others without which the project would not have advanced to this stage. These partnerships have also had wider benefits applicable to other projects and the conservation sector in general, including the development of innovative survey techniques, collaborative working, and the sharing of knowledge and expertise. At the next stage of the project these partnerships need to be strengthened and new partnerships developed.

The analysis of existing materials and the possible development and testing of a replacement roughcast should be of interest to both industry and academia. The manufacturers of Sto Render have previously advised that their European Research and Development Department would be interested in providing specialist advice and laboratory testing facilities in relation to the development of alternative roughcast repair specifications with particular focus on "waterproof but breathable" specifications. The Building Research Establishment has also been involved in initial thinking about the evidence-basis on which conservation proposals should be substantiated. Interest has also been expressed by Heriot-Watt University which sees opportunities to involve university researchers and students. There are also opportunities for learning and training. The Glasgow School of Art project team developed a number of partnerships. Use should be made of their experience and knowledge.

Such partnerships may also offer opportunities to obtain project funding, perhaps building on the success of www.mackintosh-architecture.gla.ac.uk, the University of Glasgow's Mackintosh Architecture project research project which ran from 2010 – 14 and was led by The Hunterian at the University of Glasgow.

The extent to which industry and academia can contribute to the project should be investigated further at the next stage of the project, perhaps initially, by holding a Symposium to review work to date and issues raised.

Project Stakeholders

A wide range of people are interested in the future of the Hill House, including the statutory authorities; NTS membership; The CRM Society; other national and international conservation organisations; funding agencies; and the general public to name but a few. In addition to solving the technical problems, the project also offers wider opportunities to engage, provoke and educate about all aspects of The Hill House and its place in international architectural history. Communication, Interpretation and Engagement Plans therefore need to be developed to ensure that the needs and aspirations of these stakeholders are fully recognised and the project is inclusive.

A Digital Strategy

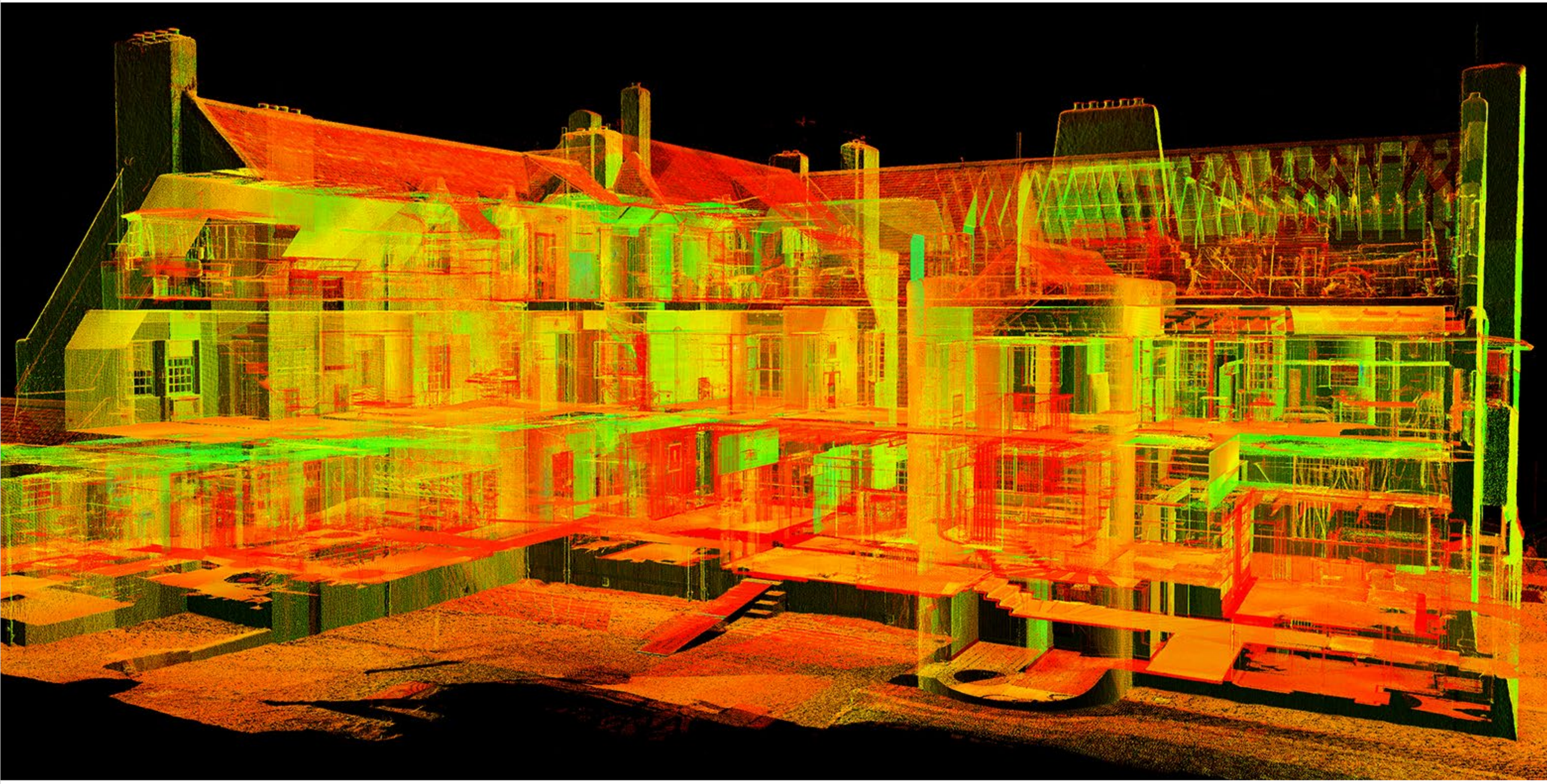
Survey plans of The Hill House have been prepared over the years by different organisations including the NTS and RCAHMS. There is however no comprehensive and definitive set of measured survey drawings of the building. HES, working alongside the NTS, has carried out a high-resolution laser scan of the exterior and interior of the whole building but this now needs to be developed into a 3D model and 2D plans, sections and elevations that can be used consistently by all those working on the project.

The potential of digital information and online digital tools to increase knowledge about Mackintosh and his legacy and disseminate it more widely in new ways was identified by Professor Pamela Robertson in 2015 and can only have grown since then with new technologies. The laser scanning, thermography and moisture-monitoring investigative work carried out at The Hill House by HES in collaboration with the NTS and the way in which it has been layered on to a digital model of the house to provide a greater understanding of moisture pathways and inter-relationships is ground-breaking. (ref Appendix Q, R, AF)

At present, information about The Hill House is widely dispersed and rarely easily accessible. The development of a web-based 3D digital model, known as Building Information Modelling (BIM), has the potential to become the prime focus for the collation, analysis, interpretation, dissemination and archiving of information about all aspects of the project. It can be the focus for technical information but also creates opportunities to collaborate, bringing together for comparison information from diverse sources. HES have, for instance, overlaid the existing 3D model with earlier photographs of the house taken by RCAHMS in the 1970s. Some changes to the fabric are obvious simply from comparison of photos but others, including the fact that chimneys have been raised or lowered in height and details changed are not. They are however immediately apparent when photos are overlaid the digital model. (Follow link to sketchfab model *https://sketchfab.com/3d-models/the-hill-house-1973-d5515eddc9d246259e5cdc52ab050e9f*)

The use of digital information does raise issues of ownership, hosting and responsibilities but these can be dealt with by developing BIM protocols for the project based on industry-standard procedures. The project team who worked on the restoration of Glasgow School of Art based much of their work on a BIM model with embedded hyperlinks and it would be sensible to consult them in terms of lessons learned prior to developing a digital strategy for The Hill House.

A further challenge is to make digital information inclusive. A number of community-based projects, including Scotland's Rural and Urban Past projects, delivered by RCAHMS (now HES), incorporated information from diverse community sources into archival databases without diluting the quality of core site records. The knowledge and experience gained should be incorporated into a digital strategy for the project. The potential for the shared use and development of digital resources should also be explored in terms of recording, archiving, dissemination and accessibility of information.



12.0

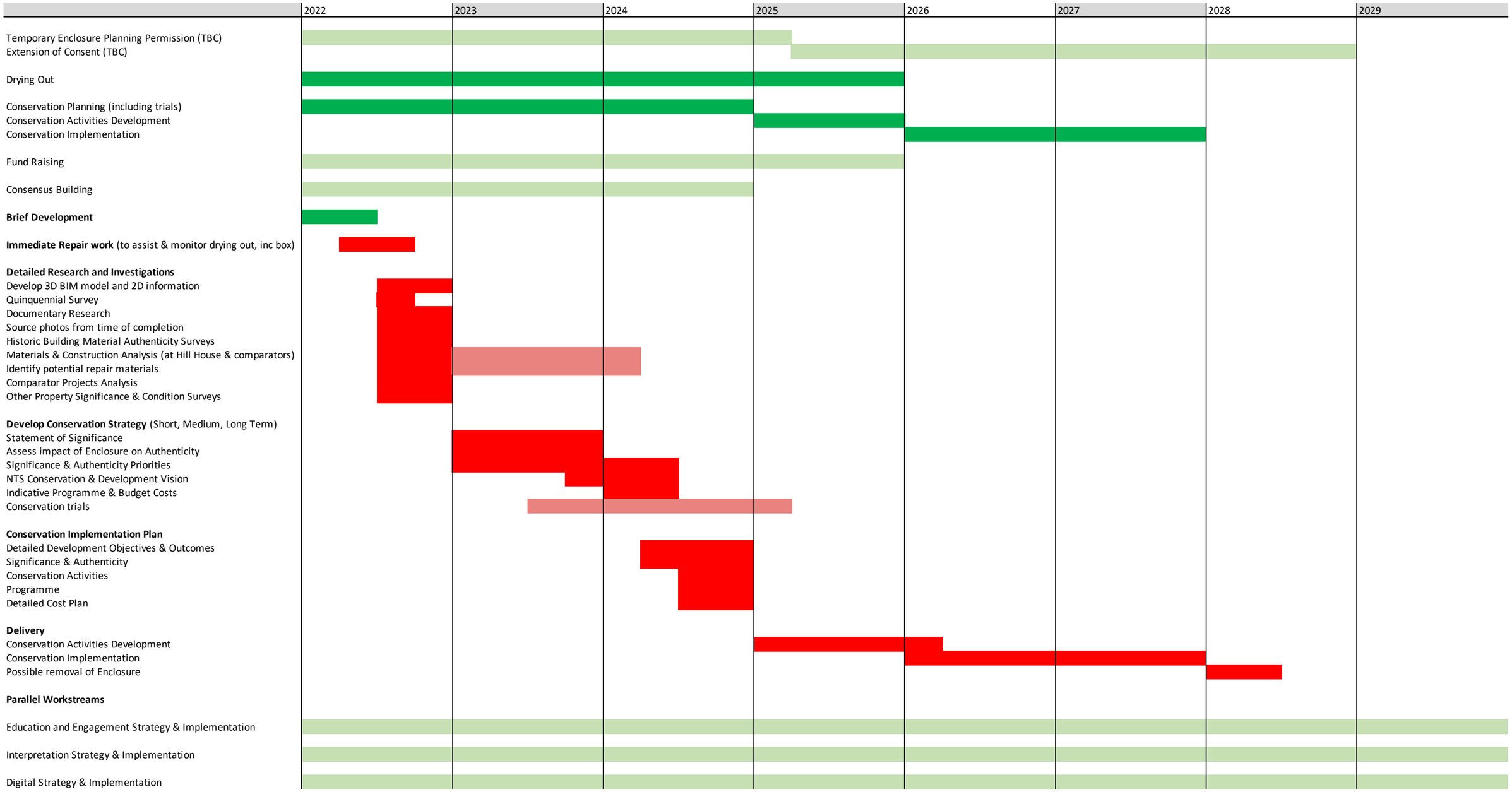
Indicative Programme

Indicative Programme

The construction of the Box has safeguarded the immediate future of The Hill House but it has a design life of only ten years. The lifespan of the Box is also covered by a planning consent which will have to be extended to keep it in place until 2029. These parameters set the overall timescale within which conservation proposals should be developed and implemented.

Charles Rennie Mackintosh died in 1928. 2028, the centenary of his death, would also be an appropriate date by which to complete repairs and reveal The Hill House once again. The bar chart programme on the following page therefore describes the key project milestones required to achieve project completion by that date.

INDICATIVE HIGH LEVEL CONSERVATION RESEARCH, DEVELOPMENT & IMPLEMENTATION PROGRAMME



13.0

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https://www.getty.edu/

The Getty Foundation's *Keeping It Modern* initiative supports the conservation of significant 20th century architecture and the Report Library makes available the resulting conservation plans and technical reports produced.

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Edinburgh
57 - 59 Bread Street, Edinburgh
EH3 9AH
0131 222 2900

Forres
29 St. Leonards Road, Forres
IV36 1EN
01309 673 221

www.ldn.co.uk

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