Traditional Materials Framework

Supporting Sustainable Supply and Best Practice Use

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Muckle Flugga Lighthouse, Shetland Islands.

Traditional Materials Framework

Supporting Sustainable Supply and Best Practice Use

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The Traditional Materials Framework (TMF) is published by Historic Environment Scotland (HES), the lead public body established to investigate, care for and promote Scotland's historic environment. It has been produced by HES to help us plan our work to maximise opportunities and address the challenges facing the sector as a whole, in relation to traditional materials.

The content has been developed based on feedback gathered from stakeholders across the sector. While every care has been taken in its preparation, Historic Environment Scotland specifically excludes any liability for errors, omissions or otherwise arising from its contents and readers must satisfy themselves as to the principles and practices described.

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Front cover image: View over slate quarry to Cullipool village on Luing. © Graham Briggs

Teviot Viaduct, Scottish Borders. © Sanne Roberts

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FOREWORD

Portree Harbour, Isle of Skye. © Lee Howard

Until around 1919, buildings in Scotland were generally constructed using a familiar palette of traditional materials, including timber, paint, lime, earth, stone, slate, thatch and ferrous metal. Usually sourced locally, the materials and associated construction details were developed to suit the particular climatic conditions of the area.

These materials were used to build the castles and abbeys that define Scotland's 'built heritage', but they also provide the backdrop to our daily lives. 'Traditionally constructed' buildings make up around 18% of our homes, 24% of our offices, 33% of our shops and 41% of our public buildings (SHEA 2024), and they will remain a significant proportion of building stock into the future. They reflect the lives of the people who used them and contribute to the identity and wellbeing of communities.

Traditional materials are essential to enable the repair and maintenance of our built environment, safeguard our heritage and deliver resilient places. Understanding their performance is key to effective adaptation in a changing climate.

Many traditional materials are natural, non-toxic, low carbon and easily recyclable, and can often still be sourced in Scotland. They have great potential to deliver environmental, economic, social and cultural benefits and contribute to construction innovation.

There is a critical need to ensure that traditional materials can continue to be accessed and used effectively. Through this Traditional Materials Framework, we aim to help address some of the challenges facing the supply and use of traditional materials in Scotland and ensure their resilience now and in the future.

David Mitchell
Director of Cultural Assets

'Traditionally constructed' buildings make up around 18% of our homes, 24% of our offices, 33% of our shops and 41% of our public buildings.

INTRODUCTION

View over Edinburgh rooftops. © Sanne Roberts

The Traditional Materials Framework (TMF) draws together the research and activity that we deliver at Historic Environment Scotland (HES). It is a tool to focus our activity and produce impactful outcomes for the sustainable supply and best practice use of traditional building materials in Scotland.

Background and scope

The TMF forms a companion publication to **Scotland's Traditional Building Materials** (HES, 2017), which provided a situation report on the provision, challenges and opportunities affecting the supply and use of common traditional materials. Since then, Scotland has weathered a global pandemic, catastrophic disruptions to supply chains around the world, and increased impacts from climate change. This has brought the vulnerability of access to the materials we need into even sharper focus.

This Framework builds on the 2017 report, updating the assessment of current challenges and opportunities in the supply and use of traditional materials, as well as setting out a delivery framework for our work to help address them.

It focuses on seven key categories of traditional building materials:

Figure 1: The Traditional Materials Framework focuses on seven key categories of traditional building materials.

Figure 2: The way materials work together affects their performance, function and appearance.

These materials are regarded as priorities due to their scale of use and/or level of risk. However, we will also work to support other traditional building materials where a need is identified. While it is necessary to focus on materials separately, in reality they are used in combination during building construction, maintenance and repair. The interactions between materials affect their performance, function and appearance and will be a key consideration for projects under the Framework.

Who is the Traditional Materials Framework for?

The Traditional Materials Framework is based on extensive consultation. Sector workshops were held in 2021-22 and 2024-25, attended by a broad range of sector stakeholders including scientists, researchers, practitioners, contractors, regulators, engineers and architects. These workshops explored the challenges and opportunities facing the sector for each material, directly contributing to production of the TMF and the prioritisation of our work.

The TMF helps us deliver on a broad range of strategic and corporate priorities, including **Our Past, Our Future: The Strategy for Scotland's Historic Environment (OPOF)**.

Outputs under the TMF will also support wider audiences' understanding of the challenges and opportunities across the sector, and of HES's priorities and work to help address them.

These wider audiences include, but are not limited to:

- Heritage, construction and built environment professionals
- Academics
- Building owners
- Communities (including rural and island communities)
- Local enterprise
- The tourism sector
- The sustainability sector

The interactions between materials affect their performance, function and appearance and will be a key consideration for projects under the Framework.

VISION

A street of white-harled houses in the village of Culross. © Laurie Risk

Our aim

The TMF aims to maximise the impact of our research and activities relating to the sustainable supply and best practice use of traditional building materials. It identifies challenges and opportunities linked to **seven key categories of material** – earth, ferrous metal, lime, paint and coatings, stone and slate, thatch, and timber – and **four priority areas** where we should focus our activity.

These priorities are:

- Understanding the material
- Identifying impacts: environmental, economic, social and cultural
- Supporting sustainable supply
- Enabling best practice use

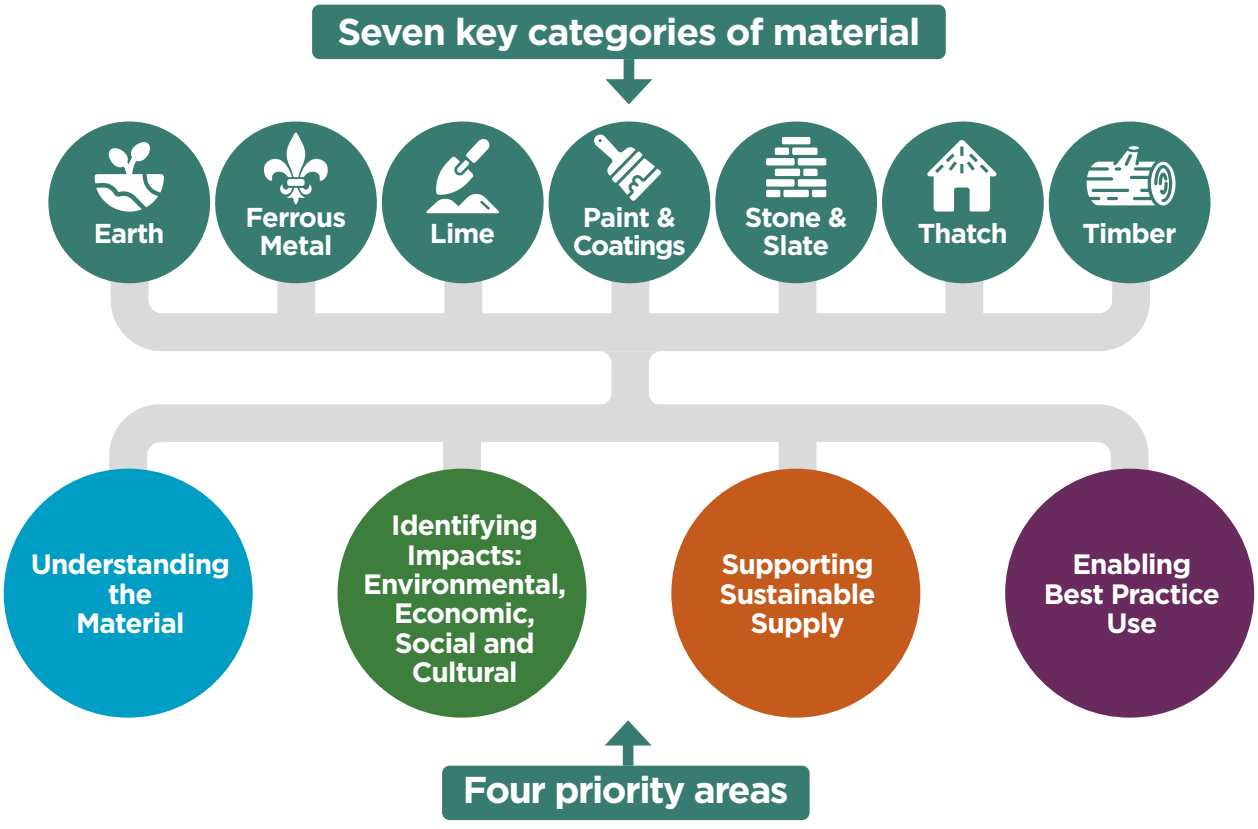

Figure 3: This diagram shows the relationship between the seven key categories of material and the four priority areas.

Strategic drivers

The TMF delivers outcomes for a broad range of national and corporate strategic objectives.

A key national driver is **Our Past, Our Future: The Strategy for Scotland's Historic Environment (OPOF)**. The TMF delivers outcomes for its main priorities, particularly delivering the transition to net zero and building a wellbeing economy.

Knowledge, materials and skills are the cornerstones of heritage management; all three are essential to deliver a resilient historic environment (Figure 4). The TMF delivers in parallel with the **Skills Investment Plan (SIP)** to ensure a joined-up approach. There is particularly strong alignment between the Framework and the following SIP pillars: traditional building skills and materials; heritage science; architecture, engineering, planning and surveying in a heritage context; conservation; industrial heritage; and net zero.

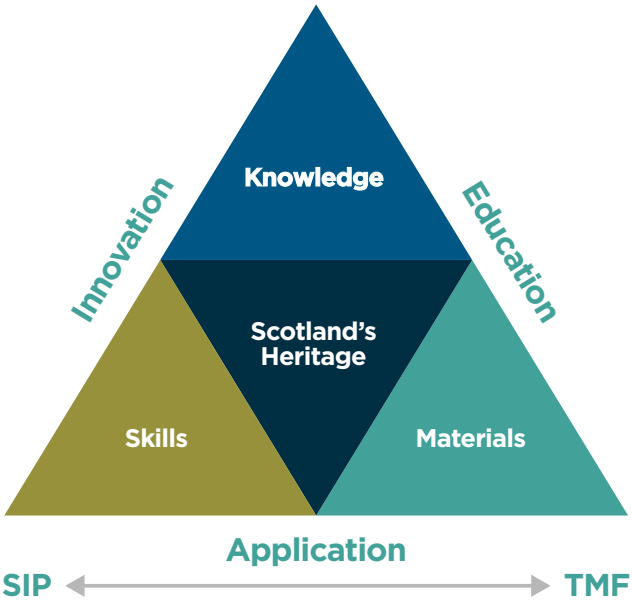

Figure 4: Knowledge, materials and skills are the cornerstones of heritage management and require joined-up delivery between the TMF and SIP.

At a corporate level, The TMF is underpinned by **Heritage for All: Corporate Plan 2025-2028** and its strategic priorities: Scotland's heritage; skills and learning; people and places; climate action; and our organisation.

The TMF helps us to develop knowledge and to access materials to help conserve the Properties in the Care of Scottish Ministers (PICs) which we look after. It delivers on the objectives of the **Asset Management Plan**, in particular 'to improve assets and manage infrastructure through conservation' and 'deliver wider benefits and opportunities through asset management in areas such as economic, knowledge generation, community engagement, sustainability and innovation'. The TMF will also ensure alignment with our upcoming **Properties and Collections Strategy**.

Traditional materials make a significant contribution to addressing climate change, including through understanding climate impacts, climate resilience and adaptation, carbon management, circular economies and sustainable procurement. The TMF will ensure alignment with the upcoming Climate Action Strategy.

Furthermore, The TMF delivers against research priorities set out in our **Research Strategy** (HES 2023), including addressing climate change, informing policy and practice, and driving innovation, and will ensure alignment with the upcoming Research Strategy.

It also aligns with and contributes to the delivery of additional sector-wide and organisational plans, including **Scotland's Archaeology Strategy** (2015) and our **Green Recovery Statement** (2022), **Intangible Cultural Heritage Policy Statement** (2020) (and emerging ICH Policy Statement) and **International Strategy** (2019).

The alignment between the priorities of the TMF (described further in the following section) and some of the key national and corporate drivers is shown in Figure 5.

	Traditional Materials Framework	Understanding the Material	Identifying Impacts: Environmental, Economic, Social and Cultural	Supporting Sustainable Supply	Enabling Best Practice Use
National Strategy	Our Place, Our Future (OPOF)	●●●	●●●	●●●	●●●
	Skills Investment Plan (SIP)	●○○	●●○	●●○	●●●
	Archaeology Strategy	●●●	●●○	●○○	●●●
HES Strategy	Corporate Plan	●●●	●●●	●●●	●●●
	Asset Management	●●○	●●●	●○○	●●●
	Research	●●●	●●○	●○○	●●●
	Climate Action	●○○	●●●	●●●	●●○
	Green Recovery	●●●	●●●	●●●	●●○
	International	●○○	●●○	●○○	●●●
	Intangible Cultural Heritage	●●●	●●●	●○○	●●○

Figure 5: Diagram showing alignment between the TMF priorities and key national and corporate drivers. This has been scored as a high, medium or low level of alignment in each case, where one relates to a low level, two to a medium level and three to a high level of alignment.

Priorities

Four priorities have been identified where we play a role in addressing challenges and opportunities relating to the supply and use of traditional materials. These include understanding the materials themselves, which provides the foundation for all of our work in this area; identifying their environmental, economic, social and cultural impacts in order to understand the wider benefits, opportunities and challenges each material presents; supporting sustainable supply, which is critical to achieving these opportunities; and our ultimate priority of enabling best practice use.

Figure 6: Our four priorities for the Traditional Materials Framework.

Understanding the material

Understanding each material and its use is fundamental to conservation. Knowing what we have, where it is located, and how the materials and their detailing vary both regionally and through time helps us to understand significance, changes and loss. It also informs decision-making when it comes to maintenance, repairs and supply of materials.

Robust survey and data analysis are at the heart of this. Scientific analysis underpins our understanding of the characteristics, performance and decay processes of materials, and informs how best to repair, source and use them appropriately.

Archive collections provide a rich source of information to help us understand the past and can inform the future. It is vital that these are easily accessible.

Understanding why materials matter and how different audiences perceive their value guides how we communicate their importance and informs decision-making, specification and application. Significance can relate to the physical aspects of the places and buildings we interact with, as well as to intangible cultural heritage such as language, traditional manufacturing processes or craft skills. Where these aspects of heritage are at risk of disappearing, activities such as recording, documentation, research and analysis are essential.

Figure 7: Robust survey and data analysis lie at the heart of informed decision-making. This rope survey team is working on Kisimul Castle, Isle of Barra. © Sandie Photos

Identifying impacts: environmental, economic, social and cultural

Materials can drive benefits for people, place and planet. Impacts require identification to ensure that opportunities are maximised and any negative impacts are mitigated or reduced.

How materials can benefit people and place

Local materials shape the fabric and character of many places. They contribute to the heritage, cultural and social value of our environment and support community identity and wellbeing. Promoting sustainable procurement and local supply chains supports the distinctive character of our environment and also provides opportunities for local economic growth, community wealth-building and resilience. Supporting responsible procurement and use of traditional materials can bring broader ethical and sustainability benefits, such as better working conditions in the supply chain or reduced impacts on natural habitats. By understanding and raising awareness of these opportunities, everyone who has a role to play in the stewardship of Scotland's built environment can make more informed choices that maximise benefits.

The vapour-open and non-toxic nature of many traditional materials contributes to better health and wellbeing by improving indoor environmental quality. There is, however, a need to understand and mitigate the risks associated with materials such as lead, silica and asbestos.

Figure 8: Local materials shape places, which in turn can support local economies, identity and wellbeing. © Sanne Roberts

How materials can help our planet

Climate action is a key area of activity to which traditional materials contribute. Ensuring buildings are well maintained and function effectively is an important first step in supporting energy efficiency and climate resilience. Understanding how materials perform also helps determine how buildings will be affected by climate change, enabling us to deliver appropriate adaptation measures.

By understanding and raising awareness of these opportunities, everyone who has a role to play in the stewardship of Scotland's built environment can make more informed choices that maximise benefits.

Figure 9: Supporting local supply chains and responsible procurement can help deliver ethical, sustainable and resilient access to materials.

Materials and construction methods of the past were often sustainable and circular, using local materials with low carbon footprints that could be re-used or were regenerative. Learning from these practices can contribute to further decarbonisation and waste reduction in the historic environment and inform future sustainable construction methods and materials. Research and innovation around the application of traditional materials in modern construction, in turn, help inform future conservation practice.

Understanding the environmental impacts of sourcing and producing materials supports procurement choices that reduce negative impacts and realise opportunities for habitats and biodiversity.

Supporting sustainable supply

Reliable access to appropriate materials is critical to enabling best practice in repairs and maintenance. Supporting local supply chains and responsible procurement can help deliver ethical, sustainable and resilient access to materials. Barriers and opportunities for supply need to be identified and addressed.

In most cases, building materials were historically sourced locally. Reliance on imported materials erodes the distinctive regional character of our architecture and reduces the ability to match the performance of the original. It also substantially increases embodied carbon while limiting local benefits and resilience. There is an opportunity to support and advocate for the use of locally sourced materials. The procurement process can help to support this, alongside ensuring ethical and sustainable sourcing.

Demand for materials needs to be understood, including new material required for repair, the re-use of historic material, and the interdependency between heritage and mainstream construction markets. Where access to material is restricted or unavailable, options for prioritisation or suitable alternatives may need to be considered.

The manufacturer, supplier, specifier and client all have a role to play in maintaining an effective supply chain. Communication between supply stages, and the availability of knowledge and skills at each stage, are key.

Figure 10: A stonemason working at Doune Castle. © Donald MacLeod

Enabling best practice use

The successful care and management of Scotland's historic environment requires a good understanding of materials and their application in order to make well-informed choices. A key part of this is sharing knowledge and developing solutions, whether this relates to producing or selecting materials, specifying repairs, or identifying opportunities to support communities and the environment.

Materials research and scientific analysis should inform – and be informed by – practice. Monitoring and feedback form an integral part of this, ensuring research and analysis is effective and remains relevant to on-site challenges. Gaps in knowledge can be identified and lessons can be learnt from projects both successful and not. We can build on this learning to deliver better preventative maintenance and proactive management practices.

Collaborative networks and easy access to up-to-date information are critical to enable effective knowledge-sharing between researchers, practitioners and specifiers.

There is also a need to raise awareness and disseminate best practice to wider audiences and mainstream contractors outside the heritage sector. Collaboration with the new build sector can drive resilience, technology, innovation and best practice across both markets.

Heritage projects operate within a wider construction sector where competing issues of cost, supply, lead-in times, regulations and health and safety need to be balanced. Best practice can provide mechanisms for balancing or prioritising these. Advocacy for traditional materials in the development of standards, codes and specifications will enable their more widespread use.

Research and innovation around the application of traditional materials in modern construction help inform future conservation practice.

EARTH

KEY FACTS

Of the estimated 200,000 earth-mortared structures that survive in Scotland, only 396 have been mapped.

A third of all waste in Scotland – 3 million tonnes a year – is earth derived from construction activity.

Earth plaster has a hygroscopic capacity ten times greater than gypsum and twice as high as lime plaster, making it more effective at regulating humidity.

Earth blocks without cement stabilisation can contain around 10% of the embodied carbon of traditional concrete blocks.

Extreme weather events are increasing the risk of railway and canal embankment failure.

Traditional earth finishes.
© Madeleine Clark

Introduction

Earth has a long tradition as a building material in Scotland and offers great potential as a sustainable choice for the future.

The term ‘earth construction’ covers a number of different techniques. These include the use of turf for roof coverings, wall construction and to protect wallheads (soft capping). Subsoils can also be used for mass wall construction (such as mudwall or clay and bool), earth cores, mortars and finishes. Subsoil mixes can be adapted, and additives such as fibres can be included, to meet certain performance or aesthetic requirements. Earth tended to be locally sourced, and due to variations in subsoils and other available materials, distinct regional traditions have developed.

As well as its use in buildings, earth is also used in structures ranging from archaeological sites such as the Antonine Wall to industrial infrastructure, including canal, rail and bridge embankments.

Archaeological excavations show that earth has been used in construction since the Neolithic period. It was a predominant construction material in Scotland until the 19th century, when lime and other materials became more common. Many earth-mortared or earth-cored buildings nevertheless survive today, although they are often misidentified or obscured behind lime.

Earth materials, including paints and renders, are enjoying a resurgence as eco materials due to their low embodied carbon, ability to regulate internal environments, and contribution to circular economies. Soft capping (soil and vegetation used to protect wallheads on ruins from decay) can introduce significant biodiversity gains. Understanding how earth materials have been used in the past can feed into future innovation.

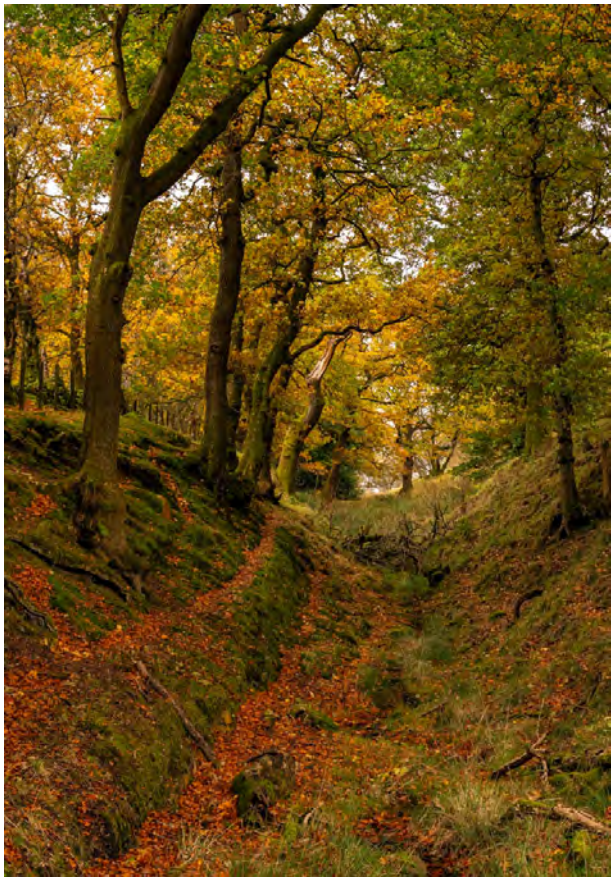

Figure 11: The Antonine Wall is one of the largest earthen structures in Britain. Part of its remains is shown here at Dullatur. © Gavin MacDonald

Earth tended to be locally sourced, and due to variations in subsoils and other available materials, distinct regional traditions have developed.

Challenges and opportunities

The table below summarises some of the areas where there are challenges and opportunities for the sector. These are based on our knowledge of the sector and on feedback from stakeholder workshops held in 2021 and 2025. They are grouped against the four priorities of the Traditional Materials Framework.

Understanding the Material	Identifying Impacts: Environmental, Economic, Social and Cultural	Supporting Sustainable Supply	Enabling Best Practice Use
• Scientific analysis • Character, performance and decay mechanisms • Scale of resource, regional variation, distribution and rate of loss • Survey and recording • Awareness and public perception	• Biodiversity • Community engagement • Health benefits • Climate change impacts and adaptation • Sustainability benefits	• Identifying and sourcing suitable subsoils • Access to turf cutting machinery • Lack of specification • Demand	• Specification and repair best practice • Collaboration • Confidence in earth building • Sourcing, selecting, processing and using subsoils (and fibres) • Building standards and insurance

Table 1: Summary of areas where there are challenges and opportunities in relation to earth.

Challenges and opportunities identified within the sector are discussed in more detail on the following pages.

Understanding the material

Earth has been used in construction far more than most people realise. More earth-built structures survive today than is often assumed. A systematic survey of earth buildings has not been completed, and earth construction is frequently misidentified or overlooked. It is also poorly represented in historic records, and where mortars are identified they are often assumed to be lime. As a result, there is not enough data to quantify the scale of historic and surviving earth-constructed buildings, their distribution, and their rate of loss.

Figure 12: Sunnybrae Cottage, an earth-mortared building in Pitlochry. Earth-cored or earth-mortared buildings are often misidentified or overlooked.

Low levels of survey, recording and analysis also limit our understanding of how earth was used and how it performs. This includes knowledge of historic construction processes, regional variations (including types of construction and their distribution) and approaches to repair and maintenance over time. The character, performance and decay mechanisms of earth as a building construction material are also poorly understood. Only a small group of specialist practitioners are able to interpret the character of the material on site, and there has been limited scientific analysis to underpin this. Greater understanding of earth–lime stabilisation, moisture properties, thermal efficiency, heat conductivity, impacts of water, and long-term performance would help to inform repair methodologies and retrofit schemes.

Methodologies for analysing earth building materials are not standardised or consistently applied. There is little awareness of the types of analysis available and of where relevant expertise can be found, creating barriers to the effective use of analysis to inform understanding and specification. However, analysis of earth from archaeological sites is an established part of accepted excavation and post-excavation processes, and there are opportunities to learn from this sector.

Public perceptions of earth often frame it as a low-value or inferior material. This is largely due to cultural associations that became embedded during the 18th and 19th centuries, and has contributed to misconceptions and limited awareness of earth heritage among professionals and homeowners.

Identifying impacts: environmental, economic, social and cultural

Earth is a sustainable construction material due to being low energy, low carbon, long lasting and low waste.

- It is relatively easy to process and uses less energy to produce and therefore has a low carbon footprint. This is reflected in life-cycle analysis and carbon calculations, but these tools are not used systematically.

Figure 13: Scientific analysis helps underpin understanding of the character, performance and decay mechanisms of earth.

- It can be easily repaired, allowing it to be retained in use over a long period of time. As well as contributing to sustainability, this gives owners a cost-effective way to maintain and adapt their buildings.
- As earth construction relies on easily available local material, it requires less transportation and does not use finite resources such as washed sand or gravel.
- Earth can be re-used again and again. It therefore has significant potential to contribute to circular economies, including the use of waste construction material on individual sites and at an industry scale.

However, as the sustainability of earth construction is poorly recognised, it often does not influence material choice at design or procurement stages.

Impacts due to climate change are not fully understood. Data and analysis are required to determine erosion rates, climate change risks and the impacts of retrofit schemes to ensure informed decision-making around climate adaptation and future conservation approaches.

The biodiversity impacts of earth materials, including turf cutting and soft capping, require greater research and awareness to reduce negative impacts and realise benefits.

The use of earth materials in construction and internal finishes can have health benefits, helping to regulate indoor environments and reduce volatile organic compounds (VOCs), but there is limited data available to support and promote these benefits.

There are opportunities to use hands-on earth building as a tool to engage with communities on topics including construction, heritage, place, wellbeing and sustainability.

Supporting sustainable supply

Sourcing earth and turf is usually not a significant challenge, particularly in a rural context and where connections with landowners can be established. There can, however, be issues in situations where a large amount of material is required or where sites are protected.

For construction using subsoils, the main challenges instead relate to the natural variability in subsoils between sites and being able to source suitable material for construction use. This requires understanding of the characteristics of the material and how to manipulate it (see 'Understanding the material' above).

For turf construction, access to turf-cutting machinery can be challenging, as commercial turf removal machinery does not cut the turf to a sufficient depth. Cutting by hand is labour intensive and is not viable at a larger scale.

Earth is often not specified for repairs, leading to a low demand for earth materials, which in turn tends to limit the development and thus availability of specialist knowledge and skills. There may be opportunities to stimulate demand through advocating increased use in both the heritage and sustainability markets in order to enable growth, resilience, investment and innovation. This could include initiatives to use construction site excavation waste for development.

Figure 14: Installing a soft capping at Melrose Abbey. Soft capping can have biodiversity benefits. © Donald MacLeod

Figure 15: Hands-on earth building at Comrie Croft, Perthshire provided opportunities for community engagement.

Low general awareness of earth as a material has led to reduced confidence and understanding among regulators and specifiers.

Figure 16: Cutting turf by hand is labour intensive and is not sustainable at a larger scale. © Donald MacLeod

Figure 17: Earth provides significant opportunities as a low-carbon construction material. There is a need to address barriers to enable wider use. © Madeleine Clark

Enabling best practice use

Collaboration is critical to ensure resilience and development in the sector. This includes knowledge-sharing between practitioners; liaison between researchers, practitioners and specifiers; and engagement with associated sectors, including mainstream construction and the sustainability sector.

Low general awareness of earth as a material has led to reduced confidence and understanding among regulators and specifiers. As a result, opportunities to use earth and ensure like-for-like repair of existing earth materials are often missed. Where earth is specified, lime is still often added to specifications where it does not form part of the original mix; this changes the performance of the mix and undermines the sustainability benefits of the material. Limited scientific analysis has been undertaken to support our understanding of performance and decay, which further reduces confidence and impacts decision-making. There is minimal guidance available for those involved in specification or repair best practice.

The knowledge and skills to source, select, process and use subsoils and fibres in construction used to be passed from generation to generation, enabling communities to maintain and adapt their buildings. These skills are now held by a much smaller number of specialists and require support, recording, understanding and disseminating to a wider audience.

Building standards and insurance requirements risk presenting a barrier to mainstream use of earth construction. Difficulties in demonstrating structural integrity and thermal efficiency within the existing frameworks is another reason why opportunities for earth construction can be missed. Standards for earth construction require development and implementation.

Figure 18: The knowledge and skills to source, select, process and use subsoils and fibres in construction are held by a small number of specialists and require support, recording, understanding and disseminating to a wider audience. © Becky Little

Our priorities and objectives for earth

Previously we outlined the four main priorities we will use to focus our activity around traditional materials. The following objectives will help steer activity for earth in relation to these priorities.

Earth Objective	Priority
E1: Develop understanding and promote awareness of the use and distribution of earth construction and earth mortars	Understanding the Material
E2: Support development of expertise in sampling, analysis and characterisation of earth and turf materials	Understanding the Material
E3: Develop understanding of the characteristics, performance and opportunities of earth and turf materials, including in relation to climate	Understanding the Material
	Identifying Impacts: Environmental, Economic, Social and Cultural
E4: Support research and guidance on the management and maintenance of earth and turf building	Enabling Best Practice Use

Table 2: Objectives for HES to meet the Traditional Materials Framework priorities for earth.

FERROUS METAL

KEY FACTS

- Scotland's first industrial-scale iron foundry (Carron Ironworks) went into blast on the 1 January 1760.
- Scotland was the world leader in architectural cast iron manufacture in the late 19th century. At the industry's peak in the 1890s, there were hundreds of foundries in Scotland. Today, only a handful exist.
- There is no known commercial supply of wrought iron worldwide.
- The Forth Bridge was the world's first major steel structure; 53,000 tonnes of steel and 6.5 million rivets were used in its construction.
- Business archives are rare. Many company records and holdings have been destroyed as businesses folded or were taken over by other companies.

A yett, or defensive gate, at Blackness Castle. © Sanne Roberts

Introduction

The term ‘ferrous metal’ refers to all forms of iron and steel. Iron includes wrought iron – shaped by hammering – and cast iron, which is shaped by pouring molten metal into a mould.

Historically, these metals have been widely used in architecture, structures, decorative items, and for agricultural and industrial machinery. They remain an integral part of the Scottish built environment, serving as street signs, railings, lampposts, park benches, fountains and much more. Their structural uses include cast iron facades, columns, structural frames, bridges and cranes.

Fuel for iron production originally came from charcoal but transitioned towards coal and coke during the 18th century. This led to large ironworks being established across the Central Belt, exploiting hot blast technology suited to Scottish iron ore. Corrugated iron developed as a cladding material in the 19th century. By the end of that century Scotland was a world leader in the manufacture of architectural cast iron and corrugated iron products; they were used across the country and exported around the world.

Steel is made through adding carbon and other elements to pig iron. Innovations in the late 19th century enabled the mass production of mild steel, leading to its dominance over iron for large-scale engineering projects.

Ferrous metalwork is generally painted in order to protect it from corrosion. This section of the Traditional Materials Framework therefore links directly with work undertaken under the paints and coatings section.

They remain an integral part of the Scottish built environment, serving as street signs, railings, lampposts, park benches, fountains and much more.

Figure 19: Cast iron was used extensively for railings and other decorative items. This example is from the Isle of Bute.

Figure 20: Scotland was a world leader in producing and exporting corrugated iron during the 19th century. This example was a school in the Scottish Borders.
© Sanne Roberts

Challenges and opportunities

The table below summarises some of the areas where there are challenges and opportunities for the sector. These are based on our knowledge of the sector and on feedback from stakeholder workshops held in 2021 and 2025. They are grouped against the four priorities of the Traditional Materials Framework.

Ferrous Metal			
Understanding the Material	**Identifying Impacts: Environmental, Economic, Social and Cultural**	**Supporting Sustainable Supply**	**Enabling Best Practice Use**
• Recognition and promotion of significance • Extent of survival, condition and rate of loss • Archives and documentation • Material character and performance • Metal, paint, and coatings analysis • Historic technological innovation	• Transition to net zero • Ethical and sustainable procurement • Environmental impacts • Retention, re-use and recycling networks	• Access to wrought iron • Loss of cast iron foundries • Architectural pattern makers and green sand moulders • Cast iron repair • Matching historic components	• Assessing structural integrity/Defect diagnosis • Finishes • Repair best practice • Access to specialist advice • 'Big-stuff' • Knowledge-sharing and awareness • Treatment specification

Table 3: Summary of areas where there are challenges and opportunities in relation to ferrous metal.

Challenges and opportunities identified within the sector are discussed in more detail on the following pages.

Understanding the material

Ferrous metalwork remains an everyday part of our urban and rural environment. It can be seen in items ranging from gates and post boxes, bandstands and bridges to industrial and agricultural sheds and machinery. It is often undesignated, and its significance can remain unrecognised. A lack of public awareness risks the unregulated loss of items such as door furniture, lampposts and railings and their replacement with poor-quality alternatives. Incomplete data is available to understand what ironwork survives, its condition or rate of loss, and to inform significance-based decision-making.

Figure 21: Cast iron post boxes are a familiar example of ferrous metalwork in our urban and rural environment. © Sanne Roberts

The history of technological innovation is still being charted, with early examples and 'firsts' of new materials and technologies being identified even now. Much can be learnt, particularly across the engineering and collections management sectors, from the successes and failures of structures that led the way in technological innovation, such as the Tay and Forth Bridges. These can inform our understanding of significance and current practice.

Archival information and documentation about more recent repairs can be useful resources to inform our understanding, and support appropriate repair and maintenance. However, as such information is often dispersed across numerous locations, including archives and personal collections, it can be difficult to access. The quality of documentation available for recent repairs varies, as there is no standardised methodology or requirement to document works.

There is little awareness beyond metal specialists of the character and performance of different ferrous metals, sometimes resulting in the misidentification of wrought iron, cast iron, steel and steel alloys. This can also lead to misunderstanding about the applications to which they are most suited. The level of metal, paint and coatings analysis undertaken also varies from project to project. As detailed in the section on paint and coatings, there is no national repository for paint samples. Paint stripping as part of refurbishment projects can cause the loss of significant information about historic coatings, maintenance and decoration.

A lack of public awareness risks the unregulated loss of items such as door furniture, lampposts and railings and their replacement with poor-quality alternatives.

Figure 22: The Forth Bridge led the way in technological innovation as the world's first major steel structure. © Sanne Roberts

Figure 23: Archive information, such as this image from the Thomas Hadden collection, can inform understanding, repair and maintenance but can be difficult to access. © Courtesy of HES (Records of Lorimer and Matthew, architects, Edinburgh, Scotland)

Identifying impacts: environmental, economic, social and cultural

Pig iron, used to make cast iron, is sourced internationally from countries including Brazil and South Africa and, until recently, Ukraine and Russia. Procurement, in general, rarely considers sustainability or the ethical impacts of sourcing pig iron or iron ore.

It is unclear how the industry can meet the transition to net zero and the impacts this transition may have on fuel sources and supply. Best practice approaches should consider how to minimise environmental impacts – for example, by ensuring appropriate detailing to make sure water sheds effectively from ferrous metalwork, or thorough surface preparation and appropriate specification to enable longer maintenance cycles. There is a strong sustainability argument to advocate for retention over replacement and re-use over recycling. There are opportunities to build upon existing networks to make access to recycled iron easier but also ethical, more resilient and more dynamic.

Supporting sustainable supply

There is no industrial supply of new wrought iron available in the UK. Access to wrought iron relies on recycled material, and it is not possible to access wrought iron that has been structurally graded or certified by an authority. The resilience and longevity of the recycled market is finite, and establishing a supply of new wrought iron is unviable. There is a need to understand when wrought iron should be prioritised for use, and when alternative approaches may be acceptable.

There are few foundries operating in the UK with expertise in green sand moulding or traditional cast-iron production, particularly for large-scale architectural components. The number of architectural pattern makers working in Scotland is limited, as are the number of companies willing to take on cast iron repair work. Access to replacement components to match other historic items, such as historic profiles of corrugated iron, can be challenging.

Figure 24: HES blacksmith Stacey Hibberd at work. It is unclear how the transition to net zero will impact fuel sources and supply.

Enabling best practice use

Not all projects receive specialist metalwork advice, due to the small number of specialist engineers, specifiers and contractors available and overall low awareness of how to access advice.

Limited understanding of how to assess and ensure the structural integrity of historic structures results in poor decision-making. Defects are often misdiagnosed, with minor surface defects wrongly identified as structural and manufacturing defects as age-related. This results in historic fabric being unnecessarily replaced. Analysis tends to focus only on surface defects, which provides a restricted picture of structural integrity. Historic metalwork actually often performs better ‘in real life’ than suggested by structural calculations.

Poor awareness of best practice approaches to repair is resulting in inappropriate specification. Greater training and promotion of best practice is required, particularly in

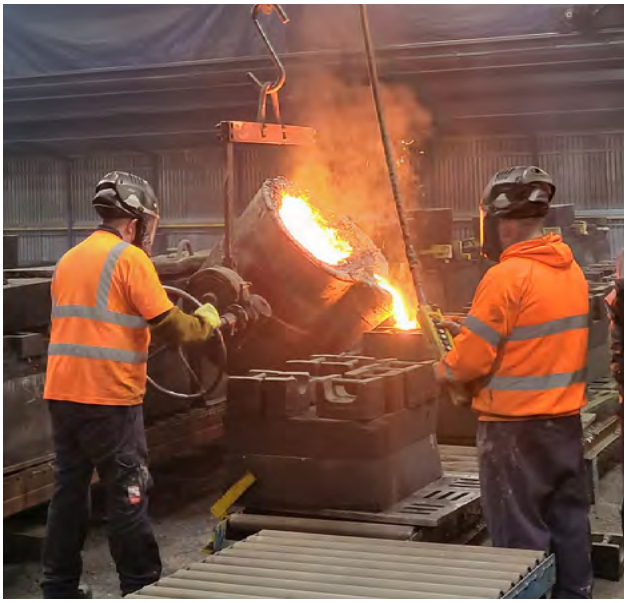

Figure 25: Ballantine Castings Limited in 2023. This foundry in Bo'ness was one of few foundries with expertise in traditional cast iron production operating in the UK. It closed in 2025. © Joanna Cole

Figure 26: Cast iron railing mould for a design found in Stornoway, Isle of Lewis. The number of architectural pattern makers and moulders working in Scotland is limited.

relation to cast iron repairs, structural (such as bridge) repair, and decision-making around when to repair, replace or use alternative materials. Guidance is also required in relation to finishes, including whether to retain original finishes, and evidence of age and use such as a historic patina.

Poor specification, or instances where best practice specifications are not adhered to, can also lead to inconsistent quality control. Quality assurance can present challenges due to cost, expertise and effectiveness of the specification. Liaison between contractors, specialists and specifiers at an early stage would help embed up-to-date best practice and ensure an agreed approach. Decisions regarding repair options will be influenced by wider considerations of cost and modern regulations, and an understanding of relative cost can inform specification. Consideration of ongoing maintenance needs, such as the importance of facilitating access for future painters, is often overlooked. This is a crucial component of a best practice approach, which requires early consideration as well as effective communication and handover to the client.

Conservation of large industrial structures or 'big stuff', such as cranes, bridges, gasholders and machinery, can present specific challenges due to scale, cost, moving parts, requirements to undertake repairs in situ, and ongoing maintenance. There is particularly limited expertise and guidance in this area.

Greater knowledge-sharing among specialists and between research and practice is key to good decision-making. Shared best practice case studies relating to different periods, different types of metalwork, and internal and external practice would be beneficial. There is a need to disseminate this knowledge and raise awareness across the wider sector.

There is a need to understand when wrought iron should be prioritised for use, and when alternative approaches may be acceptable.

Figure 27: Greater knowledge-sharing between research and practice is key to good decision-making.

Our priorities and objectives for ferrous metal

Previously we outlined the four main priorities we will use to focus our activity on traditional materials. The following objectives will help steer activity for ferrous metal in relation to these priorities.

Ferrous Metal Objective	Priority
FM1: Work with partners to improve awareness and understanding of historic industrial, structural and decorative ironwork	Understanding the Material
FM2: Investigate options to facilitate access to and re-use of ferrous metal products and components	Supporting Sustainable Supply
FM3: Support development of best practice for repair and maintenance of ferrous metalwork and structures	Enabling Best Practice Use
FM4: Explore ways to support, promote and expand documentation and archive collections	Understanding the Material
	Identifying Impacts: Environmental, Economic, Social and Cultural

Table 4: Objectives for HES to meet the Traditional Materials Framework priorities for ferrous metals.

LIME

KEY FACTS

- Until the 17th century, most buildings in Scotland were finished with an external lime coating.
- The Scottish Lime Centre Trust (SLCT) and HES mortars database contains details of over 4,000 mortar samples.
- Sixteen different historic pointing styles have been identified across Scotland.
- Internal lime finishes can improve air quality by regulating humidity and inhibiting mould growth and damp, and because they do not release VOCs.
- External lime finishes can improve weatherproofing and thermal comfort and reduce problems of stone decay and vegetation growth.
- Lime production has a lower carbon footprint than cement.

Riddle's Court, Edinburgh's Old Town.

Introduction

Lime has been widely used across Scotland for both constructing and finishing historic buildings. It is made by burning calcium carbonate from limestone, chalk or shells.

This lime is then mixed with water, aggregate and sometimes additives to form a workable material and applied as mortar to point or bed masonry and sometimes roofwork, or as a plaster, render, harl or limewash to finish internal or external walls.

The use of lime in Scottish construction dates back as far as the Roman period. Earth materials were also used throughout much of history, but as lime became easier to access in the 18th and 19th centuries, it became the prevalent material. Early patented cements only emerged and started to replace lime in mainstream construction from the late 19th century. As such, the majority of surviving traditionally constructed buildings in Scotland were built and/or finished with lime.

As well as contributing to the aesthetics of a building, lime plays a critical role in managing moisture and building performance. The function and performance of historic lime materials differed depending on the source and therefore the chemical composition of the lime and how it was processed. Although lime binders are now much more homogeneous, the choice of product (particularly its strength) continues to influence performance. Performance is also influenced by the type and proportion of aggregates, pozzolans or other additives used. Further background information regarding types of lime and lime mortar mixes is available on the **Engine Shed website**.

Lime plays a critical role in managing moisture and building performance

Figure 28: Made from burning limestone, chalk or shells, lime is mixed with water and aggregate to form a workable material.

Figure 29: Plasterwork ceiling of the Drawing Room at Bute House, Edinburgh. Lime is used internally and externally in a variety of contexts, from fine plasterwork to mortar, harl and limewash.

Challenges and opportunities

The table below summarises some of the areas where there are challenges and opportunities for the sector. These are based on our knowledge of the sector and on feedback from stakeholder workshops held in 2021 and 2025. They are grouped against the four priorities of the Traditional Materials Framework.

Lime			
Understanding the Material	**Identifying Impacts: Environmental, Economic, Social and Cultural**	**Supporting Sustainable Supply**	**Enabling Best Practice Use**
• Mortar analysis • Awareness, identification and recording • Accessing and sharing information • Public perception	• Embodied carbon • Building resilience and climate adaptation • Circular economies • Health and wellbeing benefits	• Enabling tailored specification • Regional access to a range of lime products and aggregates • Manufacture of regionally distinct products • Viability of supply	• Disjoin between analysis and specification • Lime finishes • Specification • Monitoring new products and approaches • Maintaining up-to-date knowledge • Understanding performance in practice

Table 5: Summary of some areas where there are challenges and opportunities in the sector.

Challenges and opportunities identified within the sector are discussed in more detail on the following pages.

Understanding the material

Historically, buildings in Scotland were often finished with lime harling, render or limewash externally, and lime plaster internally. The significance of internal and external lime finishes – other than those with overtly decorative finishes – is commonly disregarded. Where historic surface finishes have been removed, evidence often survives; however, depending on the experience of the practitioner, this evidence can be overlooked and go unrecorded or not considered during repairs.

Figure 30: A house on Lismore, Inner Hebrides. Evidence often survives of historic lime surface finishes. © Sanne Roberts

Historic surface finishes are therefore often lost in refurbishment works. This lack of awareness, identification and recording also extends to other aspects of the historic record, such as different pointing styles and types of aggregate.

Additionally, some materials can be challenging to identify. For example, the subtle differences between late 19th-century and early 20th-century cements and hydraulic limes can lead to confusion and misidentification. When lime finishes and mortars have been identified, the way that they are recorded, stored and the terminology used is often inconsistent. These inconsistencies can make it difficult for people to be aware of, locate and share information. This in turn limits our ability to learn from the material resource. Lack of access to information or a national repository for research, as well as limited engagement between research, regulation and practice, means that learning from research often does not filter down to practice (and vice versa).

Owners and specifiers are often unaware of the range of mortar analysis options available; when they are needed (or not needed); which type of analysis would be most beneficial; and how the results should be interpreted and applied. There is variation in the use and effectiveness of mortar analysis. Analysis is being required and undertaken as a tick-box exercise on many projects; there is a need for requirements to be more targeted and outcome focused. The financial outlay needs to be considered against the benefits analysis brings. It may be that analysis is only required for more significant projects and emphasis otherwise placed on effective specification. There is also a need to review existing historic samples in order to apply advances in technology and maximise our understanding from these.

There is a widespread, inaccurate public perception that an external ‘bare stone aesthetic’ is historically authentic and desirable. This is compounded by misconceptions about the maintenance burden of lime, how complex and potentially hazardous it is to use, and its environmental and performance benefits.

The trend towards exposed masonry has been noted for some time for exterior surfaces but is also now seen in internal scenarios. Internal lime finishes merit further understanding and guidance, as they do not receive the same level of focus as external finishes. A lack of awareness of their significance can lead to their loss during redecoration, refurbishment or upgrading works.

Figure 31: A scientist conducts mortar analysis. Specifiers are often unaware of the range of mortar analysis options available, what type of analysis to use, and how to interpret or apply the results.

There is a widespread, inaccurate public perception that an external ‘bare stone aesthetic’ is historically authentic and desirable.

Figure 32: First coat of insulated lime plaster being applied at Downie's Cottage near Braemar. Lime coatings can be used to improve building resilience and energy efficiency.

Identifying impacts: environmental, economic, social and cultural

Large-scale production of lime is carbon intensive, although less so than cement. Lime also reabsorbs carbon from the environment during the setting process, lowering its overall carbon impact. It enables the longevity of substrates and contributes to circular economy principles. However, there may be opportunities to reduce the carbon impact of production – for example, through using alternative energy sources such as hydrogen to power lime kilns.

There is also a role for lime in supporting building resilience (as it is possible to undertake regular maintenance relatively easily) and adaptation measures (such as introducing insulated or uninsulated lime coatings where appropriate to do so) to address climate change. Lime additionally can affect wellbeing and health through regulation of indoor environments, mould prevention and avoiding VOC emissions. However, these environmental and health impacts are not widely known or fully quantified.

Supporting sustainable supply

Lime has not been commercially manufactured in Scotland since the early 1960s. However, manufacturers are still producing lime in England, Ireland and on the continent, and they provide material for several lime suppliers in Scotland and the UK. It is therefore not difficult to access lime.

The products available are, however, rarely representative of historic materials used, and it can be challenging to access different lime products and aggregates to reflect these. Knowledge and understanding of how to tailor specifications using the products available is required to achieve appropriate performance in traditionally constructed buildings.

Specifiers are not always aware of the range of aggregates available and where to access them. Good-quality lime products tend to be available from specialist suppliers rather than general builders' merchants. Access to appropriate products also varies from region to region, depending on what is characteristic of that area and its remoteness. These limitations of the supply chain can impact

Figure 33: Lime kilns like these examples at Charlestown, Fife, used to operate across Scotland. However, lime has not been commercially manufactured in Scotland since the early 1960s. © Greg MacVean

Figure 34: Different lime products and aggregates can be used to tailor specifications to reflect regional variations or achieve performance requirements, but can be challenging to access. Crushed shells were used for repairs to walls at Kinneil House.

lead-in times and the ability to tailor specifications appropriately. Products that are most in demand for appropriate repair as well as being difficult to access need to be prioritised to enable improved supply.

Planning and grant requirements and the advocacy of large heritage organisations and estates are important to stimulate demand and thus support the viability of supply. Awareness and understanding also needs to be developed among mainstream contractors and homeowners, to dispel myths and encourage greater use. Demand for lime can be further stimulated through sustainable new build – due to its environmental benefits and compatibility with natural insulation products – which could help diversify and strengthen the market.

There may be opportunities to manufacture lime products locally on a small scale; for example, by using waste products such as shellfish in order to produce more regionally distinct lime products. However, approaches to ensuring consistency in grading and performance and minimising localised environmental impacts would require consideration. Alternative ways to achieve tailored specifications with the products available – such as using pure lime alongside pozzolans and aggregates – may remain an appropriate approach.

Enabling best practice use

There is a disjoin between mortar analysis and specification. The results of analysis are important to understand historic mixes and inform repair, but they are often used for specifications without correct interpretation. Analysis cannot provide a full picture of the original mortar, as not all elements of an original mix will survive within any sample.

Replicating historic mortars authentically is challenging, given the materials available today do not always match those available historically. It remains unclear why historic mortars and lime plasters tend to be more durable than replacement mortars. It is important that specifications deliver appropriate performance, behaviour and aesthetics, which may in some cases require a departure from the historic evidence.

Although a growing number of homeowners recognise the need to use lime over cement, the message needs to be more nuanced to ensure appropriate specifications are used. Many types of lime are available, each with different applications, properties and performance. Research and guidance should focus on a range of limes, specifications and applications.

A greater ongoing understanding is required of what practitioners are using on site. There is a wide and evolving range of products on the market, which presents challenges for practitioners in maintaining up-to-date knowledge and leads to variation in on-site practices. There is limited information on the exact specifications and performance of pre-mixed materials, on gauged mixes which are commonly being used on site, and on appropriate applications for limewash and mineral paints. Although the fundamentals remain the same, guidance can quickly become outdated as lime best practice and products continue to evolve. Consideration is required of how published guidance can be more agile in order to remain up to date.

Monitoring needs to be undertaken more frequently in order to understand how lime specifications are performing in practice. It can sometimes be helpful to include analysis of those that fail – to understand why they fail – as well as successful case studies. Mortars, finishes and associated substrates need to be considered holistically to support a full understanding of their performance.

The variable level of expertise and up-to-date knowledge among specifiers and contractors can result in challenges. Specifications can include out-of-date approaches, or they may not be adhered to. It is considered by some that a level of 'standard specification' may be acceptable for many less significant cases, with bespoke specifications focusing on highly significant sites and those where there are specific performance requirements. Developments in the field need to filter down to mainstream contractors, planning professionals and homeowners in digestible formats.

Figure 35: It is important that mortar specifications deliver appropriate performance, behaviour and aesthetics based on an understanding of the original.

Figure 36: There is a wide range of products and on-site practices available. Up-to-date knowledge and information-sharing are important to ensure best practice.

Many types of lime are available, each with different applications, properties and performance.

Our priorities and objectives for lime

Previously we outlined the four main priority areas we will use to focus our activity on traditional materials. The following objectives will help steer activity for lime in relation to these priorities.

Lime Objective	Priority
L1: Support and promote awareness, survey and recording of traditional lime surface finishes	Understanding the Material
L2: Review how mortar and surface finishes data is recorded, stored and made accessible	Understanding the Material
L3: Support understanding of the properties, performance and benefits of limes, aggregates and related materials	Understanding the Material
	Identifying Impacts: Environmental, Economic, Social and Cultural
	Enabling Best Practice Use
L4: Develop understanding of the key gaps and barriers in the supply of limes, aggregates and related materials	Supporting Sustainable Supply
	Enabling Best Practice Use

Table 6: Objectives for HES to meet the Traditional Materials Framework priorities for lime.

PAINT AND COATINGS

KEY FACTS

- **Scotland is known for its distinctive decorative painted timber ceilings, which flourished during the Renaissance period.**
- **Paint finishes help regulate internal environments and protect surfaces from damp and decay.**
- **Lead paint was banned from sale to the general public in 1992.**
- **Petrochemical paint is now the largest contributor to microplastic pollution in the ocean and waterways globally.**

The Grand Fountain, Fountain Gardens, Paisley.

Introduction

Paint and coatings are used internally and externally to cover building components made from materials such as timber, lime and ferrous metal.

They have been an essential part of the built environment for centuries. Evidence of coloured pigment decoration has been found on Neolithic structures at the Ness of Brodgar in Orkney. Medieval and early modern interiors were often highly decorative, and in particular, distinctive decorated timber ceilings flourished in Scotland during the Renaissance period. Externally, colour was also used to provide visual interest. For example, pigments from local sources and copperas (ferrous sulphate) were added to limewash to create soft reds, yellows and orange.

As well as providing a decorative finish, however, paints and coatings play a critical role in protecting the underlying material substrate from moisture, sunlight, microbial action and wear.

Traditional coatings include limewashes, distempers, linseed oil paints, varnishes and stains. A number of modern products are also available which are designed to be used in historic settings, including silicate or mineral paints.

Paints and coatings play a critical role in protecting the underlying material substrate from moisture, sunlight, microbial action and wear.

Figure 37: Distinctive decorative painted ceilings flourished in Scotland in the Renaissance period.

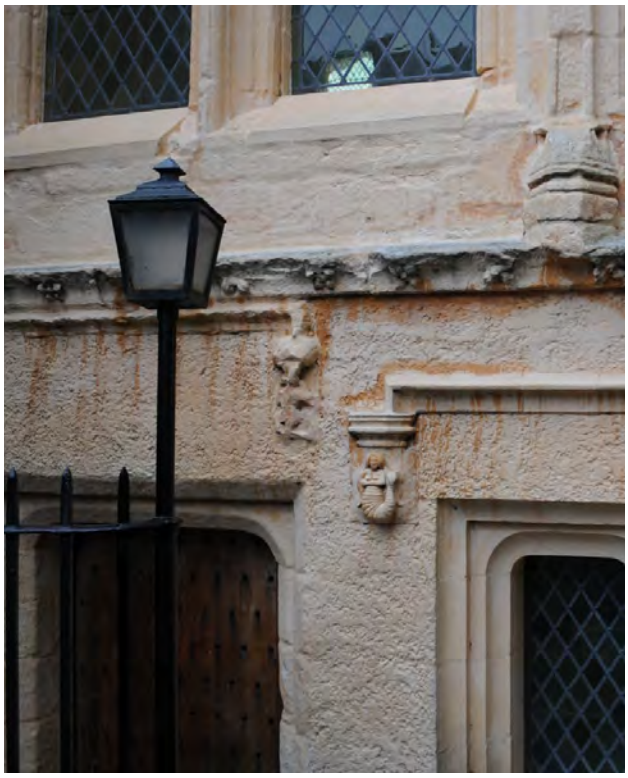

Figure 38: Limewash is a traditional coating in Scotland. As well as contributing to the appearance and character of buildings, it helps protect them from sun, rain, microbial action and wear.

Challenges and opportunities

The table below summarises some of the areas where there are challenges and opportunities for the sector. These are based on our knowledge of the sector and on feedback from stakeholder workshops held in 2021 and 2025. They are grouped against the four priorities of the Traditional Materials Framework.

Paint and Coatings			
Understanding the Material	**Identifying Impacts: Environmental, Economic, Social and Cultural**	**Supporting Sustainable Supply**	**Enabling Best Practice Use**
• Public awareness • Paint analysis and sampling • Product performance, including moisture management	• Environmental and health benefits • Gold leaf production • Lead, arsenic, asbestos and microplastic contamination • Environmental misinformation	• Mainstream access to linseed paints • Product data to identify appropriate coatings	• Surface preparation • Selection and specification • 'Big stuff' • Maintenance

Table 7: Summary of areas where there are challenges and opportunities in relation to paint and coatings.

Challenges and opportunities identified within the sector are discussed in more detail on the following pages.

Understanding the material

Paints and coatings are a common part of the built environment. However, the important role they play in performance as well as decoration is often overlooked. Public awareness in relation to paint and surface finishes is poor, with limited understanding of the extent to which buildings were coated historically and the often vibrant nature of historic decorative schemes. Paint stripping as part of refurbishment projects, which is often advocated for ferrous metal substrates in particular, can result in the loss of significant information about historic coatings, maintenance and decoration. The surviving patina of coatings contributes to the character of the historic environment but is often undervalued.

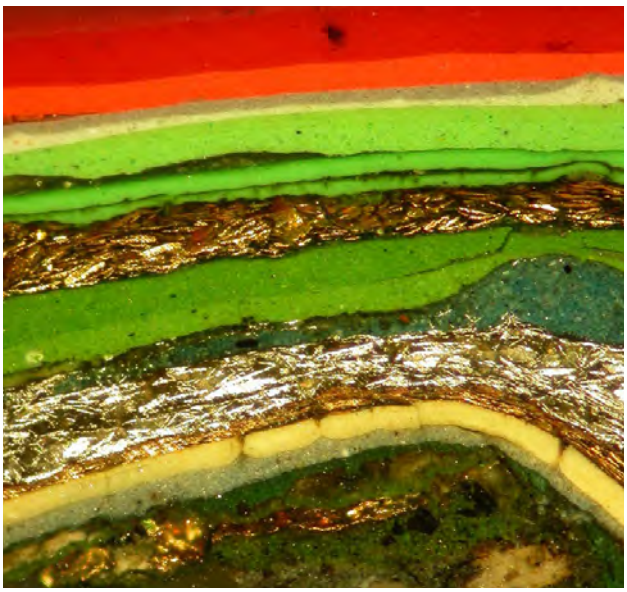

Figure 39: Close-up of paint layers which also reveals layers of gold leaf. Paint analysis can tell us much about historic decoration.

The survival of historic paints and the build-up of layers over time can tell us much about historic decoration (including colours and finishes) and their performance. Paint analysis is, however, inconsistently undertaken, and there is limited understanding of when to apply the different analysis techniques available. Methodologies for paint sampling can be inconsistent, and there is no national repository for paint samples. This limits how much we can learn from any sampling that is undertaken.

Data available on product performance generally focuses on the durability of the coating, with little information on how well it protects the substrate, how well it performs as the coating degrades over time or whether it can be removed without damage to the substrate. Testing of performance is not usually undertaken over a long time period. There is also a lack of mainstream awareness of the impact of paint on moisture management, including for silicate or mineral paints.

Figure 40: Taking a paint sample at Edinburgh Castle. Paint sampling methodologies are not always undertaken consistently.

Figure 41: Linseed paint has been used for redecoration of windows and doors at Stirling Castle.

Figure 42: Poor preparation or specification can lead to premature failure and increase the environmental impact of paint. © Sanne Roberts

Identifying impacts: environmental, economic, social and cultural

There are environmental and health concerns relating to preparing surfaces contaminated with lead paint and arsenic pigments, refurbishing painted asbestos, and the impact of microplastics from paint coatings. Gold leaf production also raises potential ethical and environmental risks. Greater awareness is needed of these issues, how to limit their impacts, and how to identify appropriate alternatives.

There is currently limited data to demonstrate the environmental and health benefits of using traditional coatings. This includes considering whole life cycles from production to application, maintenance, removal and disposal; the use of limewash surface finishes to combat damp; and the role of internal finishes in regulating air quality. Understanding of these issues is further complicated by misinformation regarding the environmental benefits of products: many paints and coatings are often cited as 'green' alternatives to modern products despite a lack of significant data underpinning individual claims.

Supporting sustainable supply

A wide range of paint and coating products is readily available in Scotland. There is, however, little domestic production of linseed paint, and linseed paints are not widely available through mainstream outlets, which limits their use. It is unclear whether linseed or casein paints could be viably produced in Scotland in order to expand the availability of traditional paints without relying on importation (and the increased carbon this requires).

It is not easy to find information on and therefore identify appropriate coatings. Product data sheets provided by manufacturers can be difficult for specifiers and owners to interpret. The terminology they use is often confusing, including how 'traditional paints' are defined and described. 'Heritage' paints may be historically accurate in terms of colour but not in terms of composition, properties or performance. A lack of awareness, knowledge and expertise in traditional paints have reduced the ability to source appropriate materials.

Figure 43: Mons Meg being painted at Edinburgh Castle. Selecting and specifying appropriate paint coatings is an important part of repainting programmes.

Enabling best practice use

Surface preparation is a key area of the repainting process, but guidance and best practice models are not easily available. There is limited advice on how the build-up of previous paint coatings affects performance, particularly in relation to compatibility and moisture management, and therefore whether it is better to remove or retain existing coatings during refurbishment. However, while full removal (particularly on metal substrates) is often advocated, it can result in the loss of the archaeological record of historic paints, the removal of highly performing historic coatings, and health and safety risks (for example, where lead paint coatings are present).

There is limited mainstream confidence in knowing how to select and specify appropriate paint coatings. This includes when to use what paint, the comparative merits of traditional and modern coatings (for instance, limewash versus mineral paint), or suitable alternatives for traditional paints where they are no longer available.

Painting and maintaining 'big stuff', such as industrial heritage and infrastructure, can present significant challenges in terms of scale, cost, in-situ surface preparation and application, and ongoing maintenance. Maintenance more generally is often overlooked and requires early consideration, regular monitoring and client engagement.

Many paints and coatings are often cited as 'green' alternatives to modern products despite a lack of significant data underpinning individual claims.

Figure 44: 'Big stuff' – industrial heritage and infrastructure – can present significant challenges for painting and maintenance.

Our priorities and objectives for paint and coatings

Previously we outlined the four main priorities we will use to focus our activity on traditional materials. The following objectives will help steer activity for paint and coatings in relation to these priorities.

Paint and Coatings Objective	Priority
PC1: Promote understanding and access to information on the historical use of coatings	Understanding the Material
PC2: Support research into the performance and characteristics of different coating systems	Understanding the Material
	Identifying Impacts: Environmental, Economic, Social and Cultural
PC3: Develop and support best practice on surface preparation, selecting and specifying coatings	Enabling Best Practice Use
PC4: Facilitate cross-sector engagement, including international expertise	Enabling Best Practice Use

Table 8: Objectives for HES to meet the Traditional Materials Framework priorities for paint and coatings.

STONE AND SLATE

KEY FACTS

- There are 198 identified Scottish building stones.
- Of 3,721 historic building stone quarries in Scotland, just a handful are now operational.
- About 80% of all stone and 90% of all slate used in the UK is imported.
- 70% of all slate now used in the UK comes from Spain.
- The use of imported slate results in around £120 million per year exiting the UK economy.
- The embodied carbon of imported stone can be six times that of Scottish material.

Stone detail at Dryburgh Abbey, Scottish Borders.

Introduction

Stone and slate are synonymous with Scotland's built environment. The country's geological diversity has led to much regional variation in building stones, both petrographically and aesthetically.

The performance characteristics of different stones and slates have influenced how they are used – for example, in roofing, walls or paving – and the construction methods and detailing required. This has produced distinctive local characteristics, engendering a strong sense of place within communities.

At the industry's peak in the 19th century quarrying was one of Scotland's largest employment sectors, with hundreds of building stone and slate quarries in operation. Strong trade links were also established between specific areas of Scotland and quarries in England, Wales and Scandinavia; for example, to provide slate to regions where it was not locally available. Today, the number of active quarries in Scotland has dramatically reduced, with only a handful of dimensional stone quarries and no slate quarries operating. Historic trade routes have also been diluted.

Figures 45 and 46: Sculpture of James IV at Stirling Castle (right) and Edinburgh Castle cobbles (below, © Sanne Roberts). The performance of different stones and slates has influenced how they have traditionally been used. Hard stones such as granite and whinstone provide durability for use in paving, while softer sandstones are well suited to intricate carving.

Figure 45: Sculpture of James IV at Stirling Castle.

Figure 46: Edinburgh Castle cobbles. © Sanne Roberts

Challenges and opportunities

The table below summarises some of the areas where there are challenges and opportunities for the sector. These are based on our knowledge of the sector and on feedback from stakeholder workshops held in 2021 and 2025. They are grouped against the four priorities of the Traditional Materials Framework.

Stone and Slate			
Understanding the Material	**Identifying Impacts: Environmental, Economic, Social and Cultural**	**Supporting Sustainable Supply**	**Enabling Best Practice Use**
• Provenance • Extent of survival, rate of loss • Condition and vulnerability • Recognition and promotion of significance	• Ethical and sustainability quarry credentials • Silica Dust • Community benefits • Re-use • Environmental benefits, including low carbon footprint	• Local and national government awareness • Snatch quarrying • Volume of demand, supply continuity • Few active quarries • Public perception of quarrying • Re-opening quarries	• Stone matching • Specification and procurement • Slating skills and knowledge

Table 9: Summary of areas where there are challenges and opportunities in relation to stone and slate.

Challenges and opportunities identified within the sector are discussed in more detail on the following pages.

Understanding the material

Stone is a signature material for Scotland, contributing to our national and local identities, tourism and economy. Its unique significance in Scotland requires recognition and promotion. There is limited awareness of how rare some materials are and how unique they are to Scotland, including materials used nationally, such as Scottish slate, and highly localised materials such as flagstone slates.

Figure 47: Scottish slates contribute greatly to the historic environment but are at risk of being lost.

Figure 48: There is limited data available on stone condition and vulnerability to decay.

Recording of existing building materials, including stone provenance, has not been undertaken for many buildings and areas. There is therefore relatively little data on the extent to which different building stones and slates have survived and are being lost. More data of this type could improve our understanding of their significance and our ability to predict demand, manage change and plan maintenance.

There are also inconsistent levels of data available on the condition of existing stone, the processes of decay and the vulnerability of different stones to decay. This has a significant impact on our understanding of the impact of climate change and our ability to plan maintenance and mitigation measures.

Stone is a signature material for Scotland, contributing to our national and local identities, tourism and economy.

Identifying impacts: environmental, economic, social and cultural

Stone has a significantly lower carbon footprint than conventional construction materials such as fired brick or concrete (**British Geological Survey 2016 Report**).This can be further reduced by using local sources of stone, as transportation has a greater carbon impact than stone manufacture. Its low carbon footprint, along with its longevity and ability to be repaired and re-used, mean that stone has significant environmental benefits. Conversely, the ethical and sustainability credentials of imported stone are often difficult to ascertain.

However, these benefits are not widely acknowledged in the heritage or sustainability sectors or integrated into specification and procurement processes. There are public misconceptions of the environmental impacts of quarrying, and there is a lack of recognition of (or data on) the wider economic, social and cultural benefits for local communities.

There has been limited awareness in the heritage and construction sectors of the health risks from exposure to silica dust in stonemasonry and the steps that can be taken to limit exposure effectively.

Opportunities for re-use of stone are often not realised. Challenges in re-using stone include destructive demolition processes, confidence in the condition of materials (including certification), difficulties in identifying an end use, continuity of supply, project lead-ins, storage, limitations of planning process to require and enforce re-use of stone, lack of statutory support, and limited awareness of previous schemes. Scottish slate, on the other hand, is often salvaged, redressed and reinstated; however, this is a finite resource and risks accelerating the loss of historic Scottish slate roofs.

Public perception of quarrying is poor.

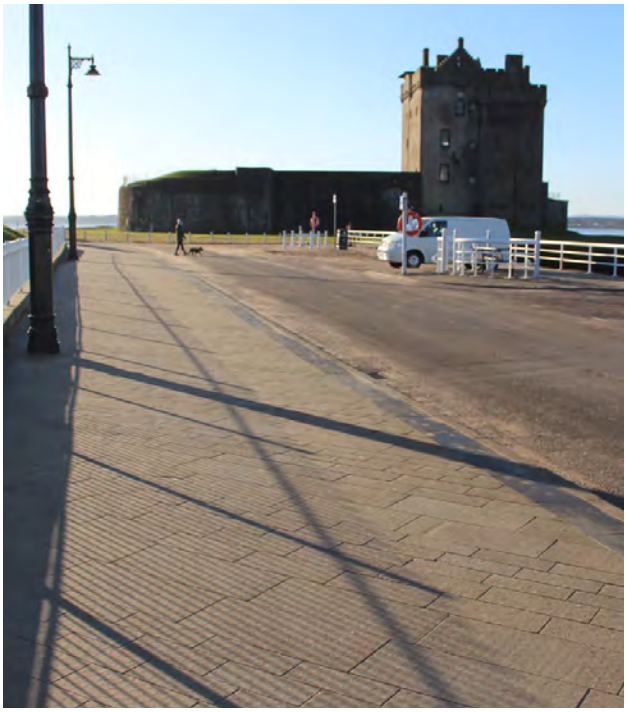

Figure 49: Transportation has a significant impact on the carbon footprint of stone. Using local stone for the Broughty Ferry flood defence scheme used almost half the carbon emissions when compared to an English competitor, and reduced emissions by more than a factor of 8 compared to stone imported from India.

Supporting sustainable supply

Scotland has the mineral resources to supply stone and slate for heritage repair, but there are very few active quarries for dimensional stone and no active quarries for slate. Many historic quarries are now designated for nature or heritage value, or have become sterilised through development. As a result, use of imported stone and slate has been normalised, which undermines the viability of native supply and appropriate stone matching. There is also increasing reliance on more modern materials as replacements for stone.

Recent research by the British Geological Survey has identified strong potential for reopening quarries in Scotland, although there is little awareness of this and the opportunities it presents. The cost and technical knowledge required to establish a new quarry remains a significant barrier, and a lack of clarity on how to do so and of quantified data on

Figure 50: Stirlinghill Quarry, Peterhead. Scotland has the mineral resources to supply stone and slate for heritage repair, but there are currently few active quarries for dimensional stone and no active quarries for slate. © Graham Briggs

Figure 51: A small historic quarry was able to supply local Ross of Mull Granite for the construction of Iona Village Hall. Opportunities like this, where smaller, historic 'snatch' quarries can provide locally distinctive materials, are often overlooked, yet they offer significant cultural and sustainability benefits. © Graham Briggs

demand can be off-putting. There are also skills gaps relating to quarrying and challenges in attracting skilled workers. Opportunities for smaller 'snatch quarries' (quarries opened for a short time, often for a specific project) have not been fully considered and may have potential to deliver low-impact quarrying, significantly reduced carbon footprints, local economic diversification and locally distinct products.

Public perception of quarrying is poor, as it is often associated with the noise, dust and traffic commonly seen at large-scale aggregate quarries. Dimensional stone quarrying, however, is small in scale and does not rely on blasting; it therefore does not have the same environmental impact. Awareness of these differences is generally low.

A reliable supply of locally appropriate stone is critical for the heritage sector, and it is important that continuity can be ensured to allow projects to move forward. The quantity of stone required for heritage projects is, however, not sufficient or consistent enough to make a quarry viable. This would require a higher volume of demand. Promoting the use of stone in new build markets, public realm schemes, and as a sustainable and structural construction material will help improve viability. This would also support the wider historic environment through embedding local distinctiveness in new development.

There is limited local or national government awareness of the potential of the Scottish stone industry, and opportunities to support indigenous supply through current planning, procurement and import policies have not been maximised. Provenance of regionally specific stones is not controlled, creating a disconnect with where materials come from and significant risks regarding stone-swapping, dilution and substitution during specification or construction stages.

Enabling best practice use

It can be difficult to secure appropriate stone matching for some repair projects, as the original stone is no longer available. Stone matching must consider both aesthetics and performance, including petrographic matching. However, aesthetics often takes precedence in current regulatory decisions. These decisions also often focus on current aesthetics, with little consideration given to how these may change in the long term through natural weathering.

Practical considerations such as cost, quantity and lead-in times can significantly impact decision-making around specification and procurement. Limited guidance is available on specification and stone matching. There are also inconsistencies in product testing, compliance with Eurocode and British Standards, availability of Declarations of Performance (DoP) and Environmental Product Declarations (EPD), and how up to date the data is in these documents. It can therefore be difficult to compare products during the specification and procurement processes. Greater alignment and early liaison between specifiers and suppliers helps facilitate the use of indigenous stone by providing a better overall understanding of factors such as lead-in times; available stone formats and their technical characteristics; what a quarry will comfortably yield in terms of sizes; how stone will naturally vary and weather; and the wider benefits of using native stone.

Scottish slate roofs form a distinctive part of the built environment due to the use of thicker slates, random widths and diminishing courses. These features were developed to make best use of the slate historically available. The loss of such details in turn risks losing the specific skills and knowledge needed to lay such roofs. Similarly, the ability to work with regionally specific stones requires experience and understanding.

Figure 52: Apprentice stonemason at work. Replacement stone should be carefully chosen to match both the aesthetics and performance of the existing stonework, taking account of petrographic matching and how the stone will weather. © Rob McDougall

Figure 53: The loss of distinctive Scottish slate roofs risks the disappearance of the specific skills and knowledge needed to lay them.

Our priorities and objectives for stone and slate

Previously we outlined the four main priorities we will use to focus our activity on traditional materials. The following objectives will help steer activity for stone and slate in relation to these priorities.

Stone and Slate Objective	Priority
SS1: Support research and access to information on building stones quarried and used in Scotland	Understanding the Material
SS2: Support measures to increase the supply of Scottish stone and slate	Supporting Sustainable Supply
SS3: Promote demand for Scottish stone	Supporting Sustainable Supply
SS4: Improve awareness of the benefits and importance of regionally appropriate stone and slate materials and detailing	Identifying Impacts: Environmental, Economic, Social and Cultural
SS5: Support research and access to information on the characteristics, performance, maintenance and repair of building stone	Understanding the Material Enabling Best Practice Use

Table 10: Objectives for HES to meet the Traditional Materials Framework priorities for stone and slate.

THATCH

KEY FACTS

- Fewer than 250 thatched buildings survive in Scotland.
- Around 20 different materials are known to have been used for thatching in Scotland. This is one of the widest ranges of thatching materials in Europe.
- Harvesting can account for up to 50% of the cost of thatching using ‘wild’ materials.
- Historically, reed was not commonly used in Scotland, but now almost 50% of Scottish thatched roofs are covered in reed.
- The RSPB’s Tay Reedbeds are the only commercial supplier of reed in Scotland.

Heather thatched roof.
© Sanne Roberts

Introduction

Thatch was traditionally a common roofing material across Scotland with a wide range of materials used. These included agricultural materials like wheat, oat and barley as well as hand-gathered 'wild' materials such as heather, rush, broom and marram grass, and coppiced hazel for fixings.

Water reed is a common thatching material in England that was not traditional in Scotland, but its use increased around the River Tay once reed beds were established there in the 18th century. Distinct regional styles developed because materials were sourced locally and usually applied by local communities to their own buildings in a manner that suited the climatic and geographic conditions. For example, marram-thatched roofs with a distinctive rounded shape to cope with strong winds developed in the Western Isles. Further information on these materials, detailing and techniques can be found in **Technical Advice Note (TAN) 04: Thatch and Thatching Techniques**.

The number of thatched buildings in Scotland has been in decline since the mid-19th century. Now, fewer than 250 such buildings survive. Because they are so rare, the majority of historic thatched buildings are recognised and protected through statutory designation.

Thatched roofs require regular maintenance to keep them in good condition. The **Historic Environment Grants Programme** is available to support the repair and maintenance of thatched roofs.

The number of thatched buildings in Scotland has been in decline since the mid-19th century. Now, fewer than 250 such buildings survive.

Figure 54: Distinct regional styles of thatching use local materials to suit climatic and geographic conditions. In the Western Isles, marram-thatched roofs with a distinctive rounded shape developed to cope with strong winds. © Sanne Roberts

Figure 55: A heather-thatched cottage at Culloden under repair. Thatched roofs require regular maintenance to keep them in good condition. © Malcolm McCurrach

Challenges and opportunities

The table below summarises some of the areas where there are challenges and opportunities for the sector. These are based on our knowledge of the sector and on feedback from stakeholder workshops held in 2021 and 2025. They are grouped against the four priorities of the Traditional Materials Framework.

Thatch			
Understanding the Material	**Identifying Impacts: Environmental, Economic, Social and Cultural**	**Supporting Sustainable Supply**	**Enabling Best Practice Use**
• Recording details, materials and maintenance • Documenting skills and practices • Historic thatching practices • Trends and rate of loss • Awareness • Durability	• Biodiversity • Environmental & health benefits • Climate change impacts • Demand and economic potential	• Sourcing 'wild' materials • Straw species and seed • Supply chain communication • Viability of Scottish-grown reed • Access to skills • Harvesting and cleaning • Hazel coppice management	• Preserving regional details and materials • Harvesting • Community resilience • Project design & specification • Maintenance, repair and adaptation • Information exchange

Table 11: Summary of areas where there are challenges and opportunities in relation to thatch.

Challenges and opportunities identified within the sector are discussed in more detail on the following pages.

Understanding the material

Thatched roofs and their specific detailing and materials are not always recorded when works are undertaken. Records of past thatch maintenance on a building are also often poorly documented, and there is a risk of these being lost when a building changes ownership. This can lead to a significant decline in the available information on thatch over a relatively short period of time.

Figure 56: Thatched roofs and their specific detailing and materials are not always recorded when works are undertaken.

There has also been insufficient documentation of traditional skills and practices, which historically were passed down through generations and form an important part of our intangible cultural heritage. Where local practices are at risk of dying out, it is particularly important to ensure they are recorded and efforts made to maintain and support them. Robust documentation of current techniques can enable them to be learnt or re-learnt in future.

Archival information and museum collections can reveal much about historic thatching practices and their evolution. Historic thatching materials can be inferred from records of crops and placenames, including Gaelic placenames. This is important, as the existing material may not be what would have been used originally, and it can help us to understand trends and rate of loss over longer periods.

Identifying impacts: environmental, economic, social and cultural

Climate change is a significant factor impacting the availability, durability and viability of thatching materials. For example, it is understood that rush has been more difficult to source in recent years, and it is unclear what strains of heritage cereals may mature best and remain most durable in a changing and increasingly unpredictable climate.

Marram, which grows on coastal dune systems in the Western Isles, has a role in coastal defence, but it is unclear what impact harvesting may have on this. It will be vulnerable to future sea-level rise and may become increasingly difficult to source. Many habitats, including machair, grassland and reedbeds, have biodiversity significance – with many being protected – and the positive and negative impacts of harvesting and importation on biodiversity need to be understood.

Figure 57: Harvesting rushes. Climate change is impacting the availability, durability and viability of materials such as rush. © Graham Briggs

There is limited awareness of, or information available on, the environmental and health benefits of thatch. These benefits relate to circular economy, embodied carbon, insulating properties and thatch as a non-toxic material. Supporting native sources of thatching material reduces their carbon footprint. There may be opportunities to use waste materials from the production of reed thatch to further improve its circular and embodied carbon potential and economic viability.

However, the rise in use of steel fixings is limiting circular economies. If contaminated with steel wire, the removed thatch is no longer compostable.

Supporting sustainable supply

Difficulty in accessing thatching materials is a significant challenge for maintaining thatched buildings in Scotland. The challenges differ depending on the material, but they generally relate to identifying available sources, harvesting processes, and skills availability.

There is limited data available to understand the availability and durability of different materials. These factors can have a significant impact on what material is chosen, leading to the loss and vulnerability of thatching practices and materials that are considered to be unviable.

For 'wild' materials in particular, there is a lack of data regarding current and potential thatch material sources. Identifying a suitable source of these materials and obtaining the appropriate permissions to harvest it can be time-consuming and limit their viability. It can also result in materials being brought from further afield when it should be possible to harvest more locally. For example, it is known that heather has been brought into Scotland from Yorkshire. The time and cost of harvesting can account for as much as 50 % of the project costs, which again, can make the material unviable.

Thatching straw is not grown commercially in Scotland. Standard modern cereal crops and harvesting machinery do not produce a product suited to thatching, and the low volume of material required is a commercial disincentive. Where appropriate traditional strains of cereal crops are sown (for example, for specialist bread or distillery use), the skills and specialist machinery required to harvest and process the straw for use in thatching also remain a barrier. There are also challenges in obtaining appropriate and sufficient landrace seed for traditional cereal crops suited to specific local regions. For example, on Shetland there is insufficient native black oat seed for local thatching projects.

Figure 58: Marram grows on coastal dune systems in the Western Isles. Research is being undertaken to understand the impact of harvesting on the habitat and its role in coastal defence. © Sandie Photography

Figure 59: Thatching straw can be difficult to source, as standard modern cereal crops and harvesting machinery do not produce a product suited to thatching. © Graham Briggs

There is only one commercial producer of reed in Scotland (Tay Reed, RSPB), and there are few commercial harvesters. Using locally sourced reed reduces its carbon footprint, and Tay reed is managed carefully to ensure sustainability and support biodiversity. However, varying annual demand and storage requirements reduce the economic viability of reed harvesting. Competition from non-native sources presents additional challenges for local Scottish production in relation to price, alongside limited awareness among purchasers of its ethical, sustainability (including embodied carbon) and biodiversity credentials.

Fixing materials, such as hazel spars, are not easily available. Hazel coppice is generally not being managed to ensure the long-term availability of high-quality hazel spars. The increasing use of steel fixings is also further reducing the availability of hazel.

Many crops require extensive cleaning following harvesting. For example, it takes time to remove wildflowers from native cereal crops grown on crofts, extraneous material from marram, or to sort reed. This adds further time and cost to the harvesting process. Innovation could bring benefits to harvesting techniques (mechanisation, improved sorting processes) or procurement practices (bulk buying, guaranteed buyer) to improve viability.

Although challenges relating to skills are more thoroughly considered through the **Skills Investment Plan**, issues with supply and use of thatched materials are intrinsically tied to skills shortages. Areas of vulnerability include harvesting wild and cultivated materials (including wetland management) as well as Scottish thatching methods. Careers in these fields can be challenging to sustain due to the low number of thatched buildings in Scotland. Thatching is not a full-time job, so most thatchers need to undertake other work alongside thatching – for instance, drystone dyking or earth construction. In order to build resilience within local communities, thatching could be considered as part of a wider rural skills portfolio.

Figure 60: Aerial view of the Tay Reedbeds. Managed by the RSPB, they are Scotland's only commercial reed producer.

The sustainability of supply and skills is limited by the small scale of demand, although there is a lack of data available to quantify this. Encouraging the reinstatement of previously thatched buildings and grant funding for business development, production, harvesting and thatching could help to boost demand and improve the viability of supply chains. However, increased demand would put pressure on finite resources. Certain hard-to-source materials might then need to be ring-fenced for use on particularly significant heritage buildings. Alternative solutions, such as hybrid roofs or substitute materials, may require consideration to maintain the viability of thatching practices.

The time and cost of harvesting can account for as much as 50% of the project costs, which again, can make the material unviable.

Enabling best practice use

Distinctive regional detailing and materials are a critical element of Scotland's thatched heritage. However, the local economies that created these distinctive traditions have been eroded, with the materials and people involved in caring for thatched buildings – including owners, heritage managers and thatchers – no longer necessarily based in the local area. This creates challenges in ensuring the preservation of regional detailing and materials through ongoing maintenance regimes, repairs and reinstatements. It also impacts the resilience of thatching within local communities, especially in remote areas.

The difficulty of accessing materials and thatchers leads in turn to challenges with carrying out timely maintenance and repairs. While regional detailing and materials remain critical, in certain circumstances it may be necessary to strike a balance that ensures a building can remain in use.

It requires considerable skill to find 'wild' materials, such as heather and broom, that are of good quality, length, consistency, etc. for thatching, and to harvest it appropriately. Limited guidance is available on this. Best practice guidance for harvesting marram grass is particularly important due to the associated impacts this process may have on climate resilience and biodiversity.

Where thatching forms part of a larger construction project, the seasonality of the thatching material is often not taken into account. This is particularly significant where 'wild' materials are used that are not typically harvested commercially or easily kept in stock. Where lead-in times and seasonality have not been considered, it may lead to long delays.

There are no standard specifications for using thatch for new roofs or new buildings in the UK. The requirements and detailing for its use are not always well understood by architects, building control officers or planners to ensure that the detail of consented designs enable thatch to be used.

Communication between landowners, suppliers, thatchers and owners is challenging for 'wild' materials and straw, as there is no clear forum for connecting each stage of the supply chain. Exchange of information regarding the support available for thatch and thatching, or the projects and research being undertaken across Scotland and beyond, is important. Without effective communication, there is a higher risk that best practice developments and new information may not be shared and opportunities for collaboration may be lost.

Figure 61: These crofters are re-thatching a croft on the island of Eriskay. In the past, thatching was traditionally undertaken by local owners or communities. Today, owners and thatchers are often based outside the local area – meaning extra care must be taken to preserve regional detailing and materials.

Figure 62: A former HES Craft Fellow picks heather. Considerable skill is needed to find and harvest heather.

Our priorities and objectives for thatch

Previously we outlined the four main priorities we will use to focus our activity on traditional materials. The following objectives will help steer activity for thatch in relation to these priorities.

Thatch Objective	Priority
TH1: Develop understanding of the distribution, demand for and use of thatching materials regionally	Understanding the Material
TH2: Support the sustainable supply of local thatching materials	Supporting Sustainable Supply
TH3: Support research and guidance on thatching practices and the performance of thatch materials	Identifying Impacts: Environmental, Economic, Social and Cultural
	Enabling Best Practice Use
TH4: Support research into cultural heritage relating to thatch and thatching skills	Understanding the Material
	Identifying Impacts: Environmental, Economic, Social and Cultural

Table 12: Objectives for HES to meet the Traditional Materials Framework priorities for thatch.

TIMBER

KEY FACTS

Around 350 Scottish oak trees – just under 100 cubic metres of sawn oak – were used to reconstruct the hammerbeam roof of Stirling Castle's Great Hall.

Each cubic metre of timber stores around 0.75 tonnes of sequestered CO_2. When used in construction, this carbon is stored for the lifetime of the building.

Only 75 buildings have been dendro-dated in Scotland, compared to more than 4,000 in England.

About 80% of the timber and timber products used in the UK is imported. Most Scottish-grown timber is used for low-value products such as fenceposts and pallets.

Hammerbeam roof at the Church of the Holy Rude, Stirling.

Introduction

Timber is one of Scotland's earliest construction materials and has enjoyed widespread and varied use throughout history.

There are many examples of its use as a structural material for roofs and bridges; for decorative and architectural elements such as panelling; for windows and doors; and for industrial applications such as waterwheels. Softwood species such as Douglas fir and Scots pine and hardwoods such as oak were typically used, with some species specified for their particular performance characteristics.

Much of Scotland used to be covered in forests. Archaeological evidence indicates that this timber has been used for construction since prehistory. It is currently thought that timber began to be sourced from further afield in the UK, and from abroad, as far back as the early 15th century. Stronger trade routes developed during the 16th and 17th centuries, including with Scandinavia and the Baltic (as described further in ScARF's **Dendrochronology Framework**). Evidence of these trade routes can be seen in surviving timbers at sites such as **Stirling Castle**. Today, over 80% of the timber used in the UK is imported.

Much of Scotland used to be covered in forests. Archaeological evidence indicates that this timber has been used for construction since prehistory.

Figure 63: Timber has been used throughout history for highly decorative ornamentation, such as this carved ceiling decoration from Stirling Castle (Stirling Head no. 2).

Figure 64: Durable hardwood timbers like oak and elm were used to construct waterwheels, such as this example at Birse Mill. © Graham Briggs

Challenges and opportunities

The table below summarises some of the areas where there are challenges and opportunities for the sector. These are based on our knowledge of the sector and on feedback from stakeholder workshops held in 2021 and 2025. They are grouped against the four priorities of the Traditional Materials Framework.

Timber			
Understanding the Material	**Identifying Impacts: Environmental, Economic, Social and Cultural**	**Supporting Sustainable Supply**	**Enabling Best Practice Use**
• Extent of survival • Awareness of significance • Recording and analysis (including dendrochronology) • Public perception of durability	• Biodiversity • Timber retention and responsible re-use • Sustainability and carbon footprint • Community benefit • Woodland and landscape management • Preservatives • Timber product innovation	• Home-grown timber supply chains • Ethical and sustainable timber import • Native woodland management (including coppice) • Future supply • Modern timber products	• Timber repair over replacement • Specifying new timber • Performance assessment (including structural) • Associated materials and systems • Timber selection • Knowledge-sharing

Table 13: Summary of areas where there are challenges and opportunities in relation to timber.

Challenges and opportunities identified within the sector are discussed in more detail on the following pages.

Understanding the material

Despite its widespread presence in our buildings and historic environment, little data is available on the extent to which timber has survived. There is low awareness of its significance. This in part is leading to the loss of many vernacular roof structures due to decay and unregulated replacement. Some recording and analysis (such as dendrochronology) is currently undertaken, but there are opportunities to increase this through grants, planning, training and by raising awareness. The identification of relevant research questions should inform when, how and which timber analysis tools are applied.

Figure 65: Dendrochronology analysis being undertaken at Newark Castle. Limited recording and analysis of timber is currently undertaken.

Public perception of timber durability is low, with a widespread expectation that timber will decay and that previously rotten but now stable timber still needs to be replaced. However, timber has been used successfully in construction for centuries. Surviving structures like the hammerbeam roof in the Great Hall at Edinburgh Castle, completed in 1510, stand testament to its longevity.

Identifying impacts: environmental, economic, social and cultural

Timber re-use has been a key part of historic and rural economies. It can contribute to circular economies and is useful when timber of similar type or quality is no longer available. However, barriers to re-use include perception, additional resource requirements, hidden fixings, assessing quality and strength, building insurance, storage, limited specification and identifying a new use for the timber. Re-use of historic timber is also contentious because it can reduce the heritage value of the timber, confuse the historic record, erode authenticity and risk incentivising removal. The priority should always be on retaining timbers in situ (see 'Enabling best practice use', below). Clarity would be useful on how re-use can be responsibly managed, what and when different approaches may be acceptable, and when recording should be undertaken.

Timber is often treated with preservatives, paint and other coatings. These need to be used responsibly to minimise damage to ecosystems. Limited data and guidance are available to help understand the impacts, how to minimise them and what alternative approaches are available.

Other approaches such as enhanced detailing, alternative processing, heat treatment or chemically modified timber can help improve durability without the need for preservatives but are not well known or promoted.

Timber is a very sustainable material. It is regenerative, sequesters carbon during growth and has a low embodied carbon footprint. The re-use and retention of historic timbers allow sequestered carbon to remain locked in. Yet the carbon footprint of timber is often not considered during specification (and its relative merits; for example, in comparing uPVC and timber windows). Supporting local supply chains, particularly when considered holistically, can further minimise carbon footprints through reduced transportation and can have a considerable economic impact for local communities.

Establishing new woodland and implementing selected woodland management approaches can enhance biodiversity. The opportunities for using timber as a sustainable, low-carbon building material need to be balanced with the biodiversity value of woodland and trees as habitats. Woodland strategies can also provide opportunities for the Scottish landscape and local community sense of place.

Innovation in timber products manufactured in Scotland (for example, wood fibreboard, modified or engineered timber products and modular systems) will provide further opportunities to maximise benefits.

Timber has been used successfully in construction for centuries. Surviving structures like the hammerbeam roof in the Great Hall at Edinburgh Castle, completed in 1510, stand testament to its longevity.

Figure 66: At Doune, larch was used to create a new bridge connection between the castle and town. Laminating the timber meant that smaller, lower-grade pieces could be used, providing more flexibility and opportunity to source the timber locally. © Rob McDougall

Supporting sustainable supply

Historic evidence of timber importation across Scotland provides a precedent for the continued use of imported timber. A decision to use imported timber may be influenced by the availability of certain species as well as by growing conditions and timber management. Where timber is imported, it is important to ensure the supply is ethical and sustainable.

The use of home-grown timber nevertheless presents opportunities for supporting local supply chains to ensure an ethical, sustainable and resilient timber supply that can also provide investment to local economies, communities, skills and environmental management. Barriers to the use of home-grown timber include lead-in times, structural assessment (including data to underpin this), timber grading (and availability of those with this skill set) and appropriate specification, detailing and processing. However, connections between forest estates, processors (including smaller sawmillers) and specifiers would help foster understanding of needs and availability and how to facilitate access to it. There are opportunities to support local timber markets through advocacy, research and guidance to address these barriers. The resilience of the market can be further underpinned through the use of modern timber products in historic settings.

There are currently few timber sources identified to futureproof the supply of home-grown timber for the heritage sector. Greater understanding is needed of the scale of demand for specific timber species and properties required in future. There are opportunities to engage with historic estate and woodland owners and feed into forestry strategies, management agreements and woodland creation schemes.

Although the scale of demand is small, steps need to be taken to ensure the future resilience of other timber heritage products as well, such as coppiced hazel for thatch fixings and vernacular roof structures. Native woodland management has a key role to play in this. Engagement with relevant landowners and woodland organisations would help to raise awareness of the requirements of

Figure 67: An apprentice joiner at our Stirling Depot repairs a timber window frame. Timber is often removed and replaced when it could easily be repaired.

the heritage sector and opportunities to bring historic coppiced woodland back into management, subject to biodiversity impacts.

Enabling best practice use

There is a lack of awareness of best practice approaches to timber repair, and it can therefore be difficult to find those with the right knowledge and skills to identify, specify and undertake repairs. Complete removal is often considered quicker, cheaper and less risky than repair, but it can result in more timber being removed than is necessary. There is also limited data available to understand the ageing effects and load duration of historic timber, to underpin performance and structural assessments and enable greater retention. There is a need for greater and more informed regulation, advocacy, training and promotion of best practice guidance.

Greater consideration and expertise are also required in specifying new timber to ensure appropriate properties, performance and finish. This requires an understanding of the characteristics of certain timber species and how they have been grown and managed.

In contexts where performance is critical, such as shipbuilding, the location and particularly the latitude from which timber is sourced can have an important influence on its performance characteristics and is rarely specified. There are opportunities for greater understanding of viable alternatives for commonly specified timbers (such as oak) to support local supply chains and a wider diversity of timber use. Timber selection on site similarly requires consideration and experience. Greater on-site understanding is required of environmental conditions like moisture and humidity and how they affect timber performance. Expertise is also needed for selecting associated materials and systems (e.g. for retrofit) to ensure compatibility and understand impacts on timber and overall building performance.

There is a need to connect sectors including timber analysts, landowners, woodland managers, timber processors, regulators, specifiers, contractors and those in the education sector to share knowledge and raise awareness.

Figure 68: Greater expertise is required in specifying new timber to ensure appropriate properties, performance and finish.

Our priorities and objectives for timber

Previously we outlined the four main priorities we will use to focus our activity on traditional materials. The following objectives will help steer activity for timber in relation to these priorities.

Timber Objective	Priority
TB1: Promote and support best practice in recording and analysis of historic timber	Understanding the Material
TB2: Support best practice in performance assessment, repair and use of historic timber	Enabling Best Practice Use
TB3: Support local timber supply chains suitable for traditional repair	Supporting Sustainable Supply
	Identifying Impacts: Environmental, Economic, Social and Cultural
TB4: Explore innovation and opportunities to support and champion the use of home-grown timber	Supporting Sustainable Supply
	Identifying Impacts: Environmental, Economic, Social and Cultural

Table 14: Objectives for HES to meet the Traditional Materials Framework priorities for timber.

GOVERNANCE AND DELIVERY

Aerial view of Comrie Croft sustainable building

Governance

Strong governance enables the Traditional Materials Framework to plan and deliver streamlined projects and effective collaboration across our organisation. The governance structure is shown in the diagram below.

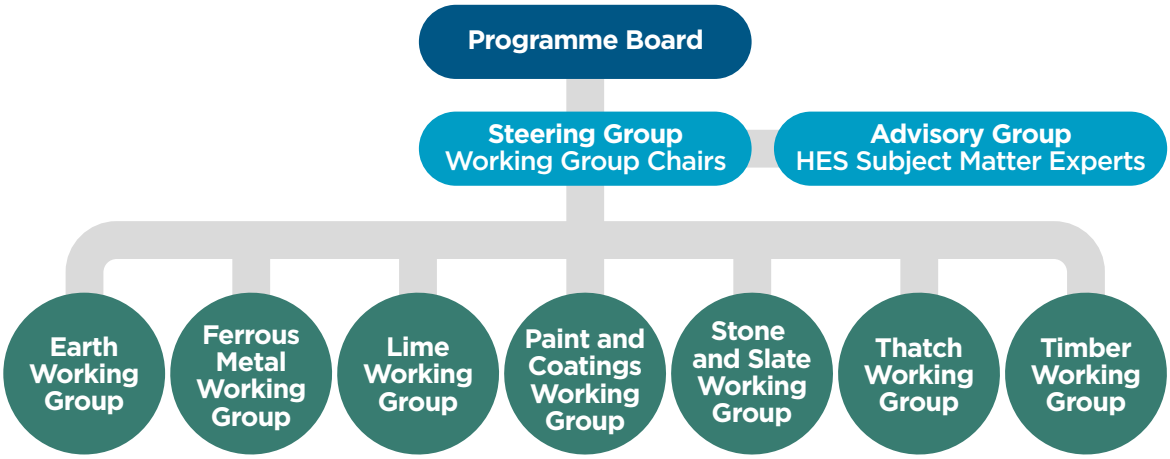

Figure 69: Overview of the Traditional Materials Framework governance structure.

The governance structure comprises the following groups and roles:

The Programme Board

The Programme Board provides strategic oversight to maximise the implementation, impact and benefit of the Traditional Materials Framework. Chaired by the Director for Cultural Assets, it includes senior representation from all relevant directorates and departments to ensure implementation and monitoring across the organisation.

The Steering Group

The Steering Group provides operational oversight and delivery of the TMF. It is chaired by the Head of Technical Conservation and it comprises the chairs of each material-specific Working Group. It reports to the Programme Board. The group agrees high-level programme priorities and progress against the TMF's priorities.

Internal Working Groups

An internal Working Group for each category of material enables greater collaboration and awareness of material-specific workstreams, projects and activities across the organisation. Each Working Group reports to the Steering Group and includes project leads as well as representation from relevant teams and directorates.

Advisory Group

A broader Advisory Group of subject-matter experts from across HES provides a further platform to ensure that the Traditional Materials Framework shapes and is shaped by the work we deliver.

We also invite feedback and engagement from external partners and stakeholders across the sector.

Delivery

Delivery of this Framework is guided by a detailed Materials Action Plan. This is a live internal document which is updated to reflect new challenges, opportunities and projects as they arise. The Materials Action Plan helps us plan, prioritise and monitor project progress.

Projects will be scoped to ensure effective delivery against the priorities and objectives of the Traditional Materials Framework. Research will be undertaken in line with our research principles and code of good practice, set out in our **Research Strategy 2023-28**. To ensure delivery of outcomes for the sector, the outputs of projects will be widely and effectively disseminated and used to influence and develop policy and guidance. Regular monitoring, review and feedback will inform future projects and project stages.

Reporting and review

While the Traditional Materials Framework is an internal document, it is important that the Framework and its outputs remain relevant and accessible to the wider sector. HES will hold a sector event every three years to provide an update on our work, and progress reports will be published alongside this. Dedicated pages on our websites will be developed to share news and information on key projects.

The TMF will be monitored to ensure it remains up to date and will be refreshed as part of a three-year rolling programme.

Stirling Castle. © Sanne Roberts

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