AtkinsRéalis

Materials Audit
City of Edinburgh Council

November 2023
Final Draft

GRANTON WATERFRONT MATERIALS AUDIT

Sensitive

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Client	City of Edinburgh Council
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Contents

Executive Summary

From both desktop studies, site visits and materials testing, this materials audit has determined that the buildings and structures located in the Granton Waterfront Scheme Area have been constructed from a similar palette of materials and the majority of the buildings were constructed in the 19th and 20th Centuries as Granton developed into an industrial area with its new harbour.

The roofs are generally pitched and covered in Scottish slate with lead flashings. Where pitched roof coverings have been replaced, they are generally re-claimed Scottish, Welsh or Spanish slates. Most of the lead flashings have been replaced with zinc, presumably due to cost and the coastal location. Flat roofs would have been covered with lead sheet, however, some have been replaced with more modern roof covering solutions, such as bituminous felt or overlaid with a liquid applied roofing membrane. Replacement lead sheet is available, however, there are no Scottish slate quarries remaining and as such, the availability of re-claimed Scottish slates has reduced. Good replacement alternative slates are those from Welsh or Spanish quarries. The rainwater goods are generally painted cast iron with half round gutter profiles and round downpipes. Where replacement rainwater goods are required, we would recommend having new cast iron rainwater goods manufactured to match the existing profiles.

The walls are mostly of solid masonry construction of either sandstone or brick bedded and pointed with lime mortar. The buff-coloured sandstone is generally from the Granton and Edinburgh area, likely from the Gullane Formation. The red sandstone used at Madelvic House is likely to be a ‘New Red Sandstone’ from the Ayrshire or Dumfries area. As there are no longer quarries operating in Scotland, a replacement sandstone will have to be sourced from an English quarry. We recommend that, where replacing or indenting sandstone is required that a sample is taken and analysed by the British Geological Survey so that they can recommend the best match.

The red and yellow bricks appear to be from a range of brickworks which were operating across Scotland in the 19th and 20th Centuries. When replacing bricks, we would recommend sending a sample of the brick for analysis to determine its porosity. A matching brick can then be specified to the right colour and size.

The Walled Garden is the oldest of the specified sites that we reviewed for the materials audit. We obtained samples of the sandstone from the walled garden and sent them for analysis to the British Geological Survey. Although we are still awaiting the full assessment results, the initial assessment found that the stone is a rather pure, quartz-rich sandstone and is light grey in colour, although it is possible that originally it was whiter. Grains appear mostly fine to medium grained, and the sample seems well cemented and therefore strongly cohesive. The type of stone is rather typical of the sandstones that crop out at the shore by Granton and Wardie, and there were various quarries (some of the large, others smaller) close to the site of the castle, which makes it likely that the stone is of local origin. The Doocot was reroofed in 2016 using reclaimed Scottish slates and is a good example of material matching during a roof replacement project.

Since the Lighthouse was altered in the early 1900s to add the first floor it has remained relatively unchanged and as such the original materials are still readable. The alterations are visible as the bricks used vary slightly in size, although the colours are well matched. The roof to the store looks as though it has been replaced with Welsh slates but they

have been well matched to Scottish slates. The lighthouse cupola is an individual detail in Granton as copper has not been widely used for roofing.

The Station has undergone a full refurbishment project to repair the building and change its use to workspace. The building is generally in good condition, with minor repairs to the brickwork. The platforms were not included in this project and as such are in need of repairs. They were constructed of engineering bricks with concrete kerbs and the top of the platform is currently covered in building rubble and weeds. The platforms form a significant part of the history of Granton Gasworks and should be repaired using engineering bricks to match, as closely possible, the existing.

Madelvic House has been extended since its original construction, however, the externals of the main building has remained relatively unaltered. It is unique to Granton in that the stone detailing is red sandstone, rather than the typical blonde sandstone. The red sandstone appears to be weathering at a faster rate than the blonde sandstone and there is evidence of mortar repairs and the stone plinth has been replaced. In conclusion, the materials used in Granton can be broadly described as Scottish slate, lead sheet, cast iron rainwater goods, sandstone, bricks and timber windows and doors. As it was not possible to sample all materials without causing damage to the buildings, we would recommend specific materials are sampled and tested by the British Geological Survey prior to finalising the specification for repair.

1. Objectives

AtkinsRéalis were instructed to undertake a materials audit of Granton Waterfront on behalf of the City of Edinburgh Council. It is our understanding that the city of Edinburgh Council is seeking to take forward the Heritage and Place Programme (H&PP) backed project Linking and restoring the fragmented heritage of Granton Waterfront, Edinburgh. The project aims to preserve and enhance the built heritage of the area, bringing multiple derelict and underutilised historic buildings and structures back into use as workspaces, events space, and community space. The project includes capital works to Granton Castle Walled Garden, Granton Lighthouse, Granton Station and Madelvic House. As such, this report provides a general overview of the materials used in the Granton Waterfront area and provides more detailed commentary on the aforementioned sites.

As part of the Development Phase of the H&PP project, the Council is required to produce a Materials Audit. The reason for this is that most conservation and heritage areas were built using distinctive, often locally sourced, materials which are a defining part of their character. This audit will provide a summary of the materials used to construct the historic assets in the Granton Waterfront area, including:

- Typical materials used in the area;
- Distinctive or significant materials noted in the area; and
- Significant local materials sources or quarries (historic and current).

This Materials Audit follows Option 2 of the guidance set out by Historic Environment Scotland (HES), which includes:

- Identification of the material types and varieties used to construct historic assets in the scheme area (e.g., stone, or slate types).
- Testing / analysis of the material ideally from the repair and resilience projects to be included in your scheme.
- Identification of where the material may originally have come from (e.g., quarry).
- Recommendations for matching the material from currently available sources for repair (e.g., currently active quarries which supply a close stone match).
- A condition survey of the material type, such as the stone masonry of buildings within a defined area.
- Recommendations for repair/maintenance.

The intention is that the outcomes of this audit will inform future specifications for design and repair projects undertaken by the client in Granton Waterfront.

Firstly AtkinsRéalis undertook desk-based research to gain a better understanding of Granton Waterfront and the buildings mentioned above and consulted the City of Edinburgh Council's Planning service and HES. We then completed an external (and internal where possible) visual inspection of the properties and Granton Waterfront in

general on 23rd August 2023. The weather conditions were dry and cloudy with a temperature of 19 degrees Celsius. Whilst on site we recorded as much visual information as possible about the materials used to construct Granton Castle Walled Garden, Granton Lighthouse, Granton Station and Madelvic House and other significant buildings in the area. We also collected two samples of stone available on site in the Walled Garden and sent the samples off for testing at the British Geological Survey and the Scottish Lime Centre.

This report outlines our findings from our research and makes recommendations as to appropriate materials and techniques for repair.

2. Scope

This materials audit will provide narrative on the building materials present in the Granton Waterfront area outlined in red in Figure 1. Specifically, it will focus on the following buildings and structures:

- Granton Castle Walled Garden, West Shore Road
- Granton Lighthouse, 20-22 West Harbour Road
- Granton Station, 1 Granton Station Square, Edinburgh EH5 1FU
- Madelvic House, 37/1 Granton Park Avenue

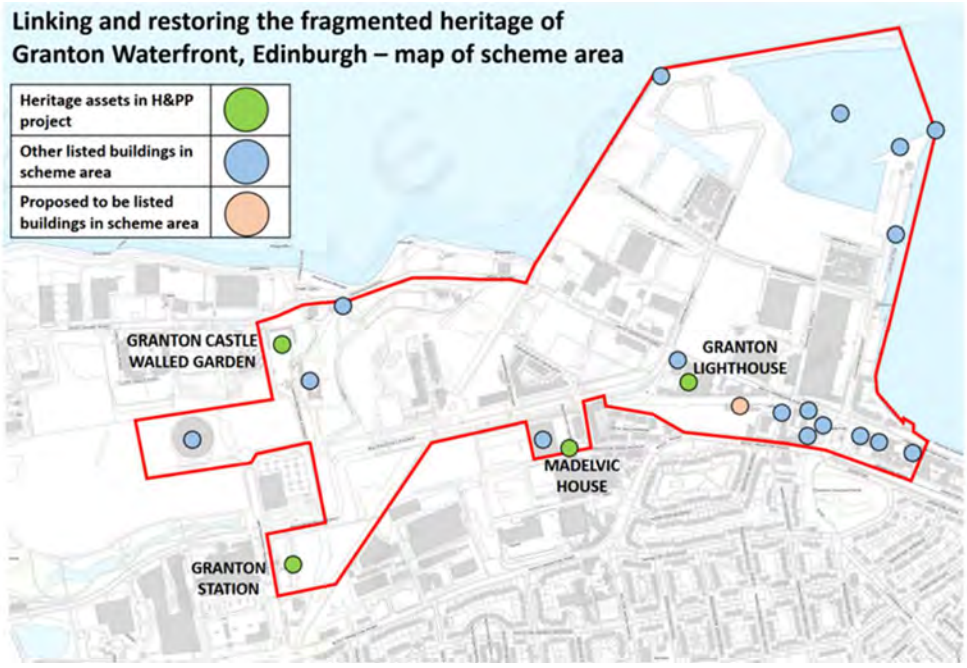


Figure 1: Map of Scheme Area provided by City of Edinburgh Council

3. Methodology

Initial Meeting

An initial meeting with the client's representatives was held on Thursday 20th July 2023, via video conference. This allowed all the team members to be introduced and allowed for the clarification of any queries.

Desktop Study

Preliminary desktop research was carried out to assess listed building entries for the buildings in question as well as previous planning applications that have been made for the buildings, designs and other documents held by the Council, including the Area Character Appraisal and Conservation Overview for Granton Waterfront. During this stage we consulted the City of Edinburgh Council and Moses Jenkins from HES. We also reached out to John Lawson, the City Archaeologist, but have yet to receive a response.

Site Visit/Assessment

On 23rd August 2023, Keith Dyer, Antonio Cabello and Fiona Arnot from AtkinsRéalis attended Granton Waterfront to survey the buildings and structures included in this audit. We identified in situ material types and varieties used to construct the buildings within the wider scheme area, and in particular the buildings listed in the brief. Representative samples of stone found in the Walled Garden were taken for further analysis by the British Geological Survey. Taking stone samples from the other sites, which were in relatively good condition, was not considered to be appropriate. The site visit was also used to record typical and distinctive construction details as well as general condition of the materials subject of study as well as typical material defects identified.

Sample Analysis

During the site visit we collected two samples of the stone found in the Walled Garden and sent them to the British Geological Survey for further analysis. The initial visual analysis found that:

The sample received is a rather pure, quartz-rich sandstone, light grey in colour, although it is possible that originally it was whiter. Grains appear mostly fine to medium grained, and the sample seems well cemented and therefore strongly cohesive. The type of stone is rather typical of the sandstones that crop out at the shore by Granton and Wardie, and there were various quarries (some of the large, others smaller) close to the site of the castle, which makes it likely that the stone is of local origin. Amongst those were the Granton Quarries, which extracted high quality white sandstone from the Gullane Formation *of Carboniferous age (c.300 to 250 million years ago), which amongst other lithologies, comprised high quality sandstones, not too dissimilar to the sample received. This geological formation is well known for producing the Craigleith Sandstone, from which much of Edinburgh's New Town (and other buildings) are made of, but the sample received from Granton Walled Garden is not quite at the same level of quality as the highest quality of Craigleith sandstone obtained from the Granton Quarries. Still, it has a character that fits the general appearance of other local sandstones and it may have been obtained from the geological horizons and quarries closer to the site of the castle.*

Petrographic analysis will confirm this initial assessment. We also conducted a visual analysis of other materials on site, in particular the slate used on the roofs. This involved reviewing the colour, thickness and texture of the slates to determine the likely source of the material.

The stone to Granton Station and Madelvic House was considered to be in good condition and damaging the building to obtain a sample was considered inappropriate. As such, we would recommend these stones are tested when stone repairs are required in the future.

Draft Report

Based on the information extracted from the site visits and the materials analysis and well as from the conclusions following the desktop study, we prepared a draft report for the City of Edinburgh Council to review. The draft report was issued to the client on 27th October 2023.

Draft Report Discussion Meeting

On 30th October 2023 a video conference meeting was held between Atkins Réalis and the client to review the draft report and discuss any comments or queries.

Final Report

Following our meeting to discuss the draft report, we finalised the report, incorporating any comments or feedback provided to us.

4. General narrative on materials in Scheme Area

Scheme Area

Granton Waterfront is situated to the north of Edinburgh city centre on the shores of the Firth of Forth. It stretches from Cramond in the west to Granton Harbour in the east and is connected to adjacent areas of Pennywell, Muirhouse, Pilton, Trinity and Newhaven.

The City of Edinburgh Council received funding from the National Lottery Heritage Fund and Historic Environment Scotland's Heritage and Place Programme to develop ideas and proposals for the refurbishment of Granton Lighthouse, the former Granton Gasworks railway station platforms, Madelvic House and Granton Castle Walled Garden. Their plan is *…to make Granton Waterfront a new sustainable coastal town for Edinburgh*… and there is strong community support to protect the local heritage and bring listed buildings in the area back to life for local people and visitors to use and enjoy.

History of Granton

Granton first appears on maps dating back to the 17th Century, with mentions of Granton Castle, Granton Burn and Granton Beach. Granton Burn now runs through Caroline Park and down to what was Granton Beach. It is thought that the name either means Grant's Town or Grant's Dun (hill).

Granton Castle was one of the first recorded structures in Granton and dated back to the 15th Century. In the 18th Century it fell into disrepair and was then undermined by quarrying in the early 20th Century which led to its collapse.

Prior to industrialisation, Granton was manly agricultural in use and, unlike other coastal towns in the area, there were no historic settlements other than some large country houses such as Caroline Park. Caroline Park, originally known as Royston House, was originally a mansion constructed in circa 1585 for Andrew Logan, it was then re-built for Sir George Mackenzie in the late 17th Century. In 1739 it was sold to the 2nd Duke of Argyll who renamed it Caroline Park in honour of his daughter. In 1793 it passed by descent to the Duke of Buccleuch and it remains in private ownership.

Figure 2: Roy Military Survey of Scotland, 1747-55 showing Granton and Caroline Park Roy Maps and Gazetteer - Map images - National Library of Scotland (nls.uk)

In 1834 it was decided that Granton would be the location for a new harbour for Edinburgh and work began to construct the harbour in 1837. The central pier was opened on the same day as the coronation of Queen Victoria in 1838. In addition to this Granton Harbour was the location of the world's first 'ferry-train', with a paddle steamer carrying locomotives over the estuary from 1850 until the Forth Bridge was completed in 1890.

Figure 3: 1834 Granton - MSS Chart of the Firth of Forth from Queensferry to Inchkeith, showing the relative position of the new Granton Harbour View map: , Granton - MSS Chart of the Firth of Forth from Queensferry to Inchkeith, showing... - Town Plans / Views, 1580-1919 (nls.uk)

Figure 4: 1856, the harbour had been constructed. Note Tile Works in Granton. Ordnance Survey of Scotland First Series, Sheet 32, 1856 Old maps of Britain and Europe from A Vision of Britain Through Time

Figure 5: 1885, the harbour had been constructed, the railway built, housing for workers along Lower Granton Road had been built and Granton Square and Granton Road were constructed.

Granton Harbour became a key port for the export of coal and the import of raw materials to make paper. Other industries that have thrived in the area over the years include Granton Quarry which provided stone for parts of Holyrood Palace and Granton Harbour. Granton Gasworks which were constructed in the late 1800s to provide gas to the Edinburgh Area and Granton Station was built from 1898-1904 to provide transport of material resources and workers. Granton Station was linked to the wider rail network via Granton Mains. In addition to this, Madelvic Motor Carriage Company, established in 1898, was located in Granton and is the oldest surviving car factory in Britain.

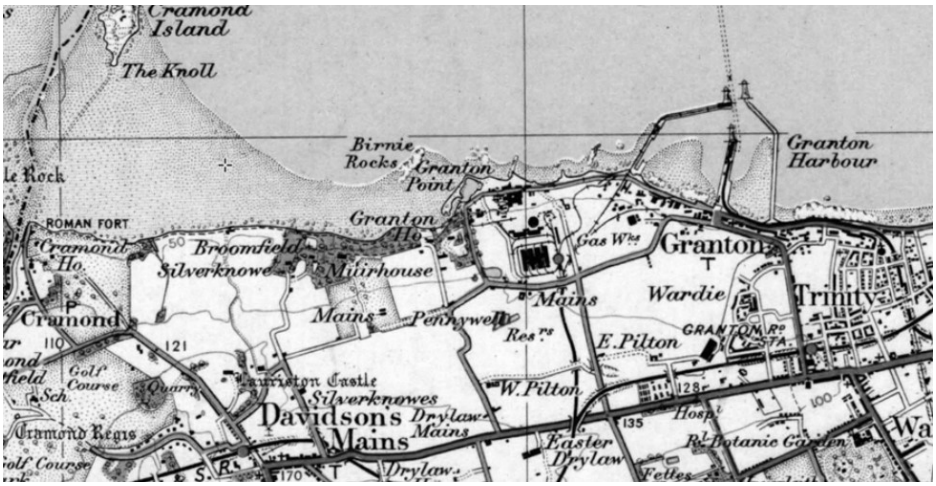


Figure 6: In 1920 much of Granton was still in agricultural use. The gasworks opened in 1903 and after WWI the boundaries of Edinburgh were expanded to take in the whole of Granton. Note the ferry train route.

Figure 7: Ordnance Survey of Scotland, Popular Edition 1925 Old maps of Britain and Europe from A Vision of Britain Through Time

From 1932, Granton was developed as a residential area by the council, with over 1,500 homes being created by City Architect Ebenezer MacRae.

A growing fishing industry meant that by World War II there were more than 80 trawlers based there and during WWI Granton Harbour was used as the base for minesweeping ships, while from 1942-1946 it was home to HMS Lochninver – a minesweeping training facility.

Figure 8: Geographical Publications Limited, Land Utilisation Survey of Britain, 1933 Old maps of Britain and Europe from A Vision of Britain Through Time

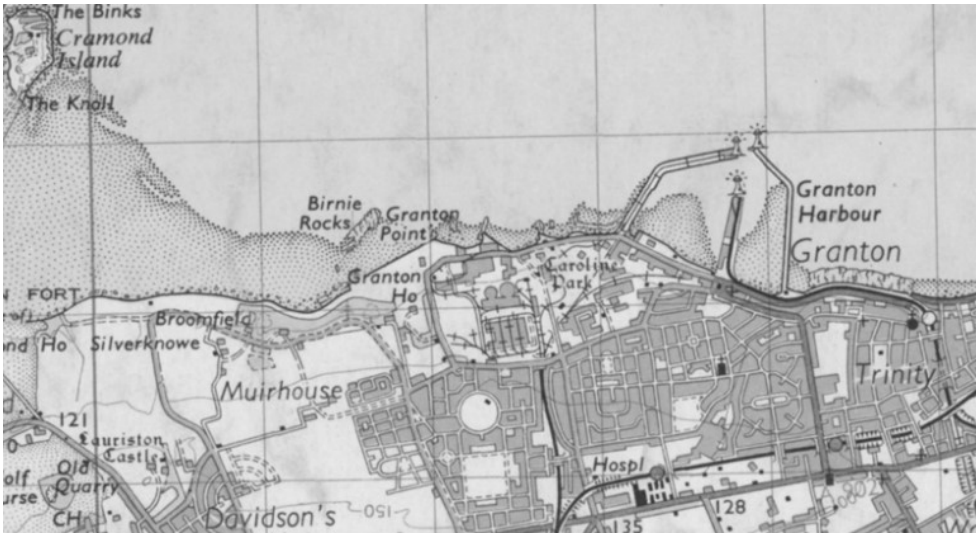


Figure 9: 1955 Post war Granton was developed to include dense housing, industry, shopping and transport links.

Much of West Granton was demolished in the 1990s and the area is now part of a significant redevelopment plan.

Typical Materials used in Granton Waterfront

During our site visit we walked along West Harbour Road, West Shore Road, Waterfront Avenue and Waterfront Broadway to review the typical materials and architectural details used in the Granton Waterfront area. We focussed on the heritage assets in the area noting similarities in materials, architectural detailing and any particularly unusual or individual features.

In general, the building materials used in the Granton Waterfront area are the same as those used across Scotland, with pitched slate roofs, lead flashings, cast iron rainwater goods, solid masonry walls, timber windows and doors. In the following section we discuss the materials found in more detail.

Roofs

Roof coverings within the vicinity/surrounding areas are primarily slate. These are typically Scotch slates laid in the traditional Scottish diminishing courses pattern, with only very few buildings provided with other types of roofs covering such as terracotta pan tiles. Flat roof sections are largely lead.

Some buildings have undergone various degrees of interventions, involving the replacement of the original roof coverings. As a result, we have identified some roofs that have been re-slated (partially or fully) with other varieties of slates, such as Welsh and or Spanish, laid in different slating patterns and flat roof sections replaced with bituminous roof felt covering or overcoated with a liquid applied roofing membrane. There are also some buildings of industrial use, where the original roof covering has been replaced with roof coverings of a modern type such as PVC-coated aluminium sheets and the like.

Roof flashings are predominantly traditional lead and zinc flashings. Rainwater goods are predominantly traditional half-round cast iron gutters and round downpipes.

Caroline Park House has two ogee roofed pavilions to the principal (south) elevation, the design of which is French-influenced, and is a unique detail in the Granton Waterfront area. The smaller size of Scottish slates makes them more suitable for curved roofs.

Figure 10: Caroline Park House south elevation.

Walls

Similarly, to the rest of Scotland, most of the surviving structures in Granton constructed before the 20th Century are of solid masonry construction, built using sedimentary stones (such as sandstone) or brick with lime mortar bedding and pointing.

In Granton Waterfront the majority of the stone is sandstone, the most common being a blonde coloured, softer sandstone and the other a grey, harder sandstone. There are a three main stone finishes/ types of wall:

- Ashlar sandstone
- Coursed sandstone
- Rubble stone

Ashlar sandstone is where the stone is cut into large blocks of the same size and laid with very thin mortar joints. It is more expensive than other methods and as such, is normally used for principal elevations and high-status buildings. In the Granton Waterfront area the notable ashlar sandstone buildings are Caroline Park, 1-4 Granton Square and 8 Granton Square (former Granton Hotel). Caroline Park House was constructed in 1680-90s, with the north wing added in 1740s, and as such is of a more traditional Scottish style. Both 1-4 and 8 Granton Square were built by the Duke of Buccleuch circa 1838 and are of classical design with ashlar band courses, V-jointed angle quoins, eaves cornices and architraved windows and doorways. Ashlar sandstone is also used as capping and kerbs to Granton Harbour walls.

Figure 11: 1-4 Granton Square

Coursed sandstone is used on many of the stone buildings Granton, including the former Customs House, Granton Harbour Middle Pier Warehouse and the Former Bonded Warehouse. The walls are of coursed stugged sandstone. The Mid-Pier Warehouse dates from the 1840s and has angle quoins, a band course and segmental arch openings. The Custom House and Former Bonded Warehouse date from the mid-late 1840s and are more classical in their detailing with droved ashlar dressings, architraved doors and stone window cills.

Rubble stone walls are cheaper to construct and were used to form side and rear elevations, outbuildings, and garden walls. Rubble was used for the core of Granton

Harbour walls and for the garden walls and outbuildings to Caroline Park and Granton Castle.

Figure 12: Former Customs House

Brick has been used in Scotland since Roman times but was more widely used in Scotland to construct industrial buildings during the industrial revolution and Granton was no exception to this. Whilst on site we found a variety of bricks, primarily from brickworks located in the central belt, which was where the greatest deposits of raw materials were found, and thus the most brickworks. There are generally two types of clay-based material used to manufacture bricks in Scotland, namely pure clays and colliery shale. Pure clay bricks are of a higher quality and strength and are generally used as facing or engineering bricks, whereas shale is not suitable for the manufacture of high quality facing or engineering bricks and instead made colliery bricks. Such bricks were usually used for internal partitioning or rendered over as their consistency did not withstand exposure to the weather and the colour and pattern varied. There are also bricks made from white clay, which are commonly used for window and doors surrounds, and glazed bricks which are normally used for decoration or for a location which needed higher levels of sanitation.

Madelvic Motor Company Factory, the old railway goods shed on Oxcraig Road and Granton Lighthouse are a few examples of brick structures in the scheme area. The bricks are generally red facing bricks with white or yellow facing bricks to window and door openings. Brick was also used widely for garden walls due to its thermal properties, which is evidenced in Granton Castle Walled Garden where brick has been used to build the base walls for greenhouses.

Both stone and brick buildings are traditionally built using lime mortar for bedding and pointing. Lime mortar is made by mixing lime, aggregate (usually sand) and water. The choice of aggregate can effect the performance of the mortar as they can effect the setting of the mortar and influence air and water movement within the mortar. Sand, gravel and crushed stone are the most commonly used aggregates. Additives can be added to mortar mixes to improve their performance, for example ‘Pozzolanic’ materials such as brick dust and fly-ash promote setting and can change the colour. In Granton there is evidence of seashells being used in the lime mortar, particularly to Granton Castle Walled Garden which suggests that the aggregate may have been sand collected from the local beach.

Concrete began to be used more commonly following the First World War and in Granton there is evidence of this around the harbour area, including Granton Harbour Mid Pier Leading Light which was built in 1936 of reinforced concrete with latticed glazing in steel framework.

Windows

In Granton Waterfront most of the windows are timber and are either fixed or opening casements. Timber sash and case windows of various sizes are the most common and it looks like some original glazing is still in situ, however, some panes have been replaced with modern single glazing or damaged by vandalism. In addition to this, there are some modern UPVC windows that have been installed.

Distinctive or Significant Materials Noted in the Area

The materials which are most distinctive in Granton are:

- Blonde sandstone;
- Dark grey sandstone;
- Red bricks with yellow/ white bricks to window and door openings; and
- Scottish slate.

Significant Local Materials Sources or Quarries

Sandstone

Edinburgh's top quality building sandstone was mostly supplied by the Gullane Formation which consists of fine- to course-grained sandstone interbedded with grey mud-stone and siltstone. The two principal stratigraphic units which have been worked around Edinburgh are the Craigleith Sandstone and the Ravelston Sandstone, collectively known as the Granton Sandstones.[1]

According to the Building Stone Database for Scotland there were five stone quarries local to the Granton Waterfront area:

- Granton Sea Quarry – Gullane Sandstone. The earliest recorded use of stone from Granton Sea Quarry was at Holyrood Palace in 1532 and later uses include Granton Harbour's pier and breakwater, the Granton Hotel and the statue on top of Nelson's Column (figure XX) in Trafalgar Square. The quarry was nearly 80 feet deep and covered over 8 acres until it collapsed and flooded after a storm in 1855. The quarry is currently inactive.
- Muirhouse Quarry – Gullane Sandstone, currently inactive.
- Pennywell Quarry – Gullane Sandstone, currently inactive.
- Royston Quarry – Gullane Sandstone, currently inactive.
- Wardie Quarry – Gullane Sandstone, currently inactive.

[1] Building stones of Edinburgh: stratigraphy and origin of sandstones - MediaWiki (bgs.ac.uk)

None of the “Granton Sandstones” quarries in and around Edinburgh are currently active and have been unavailable in the market for several decades. [2]

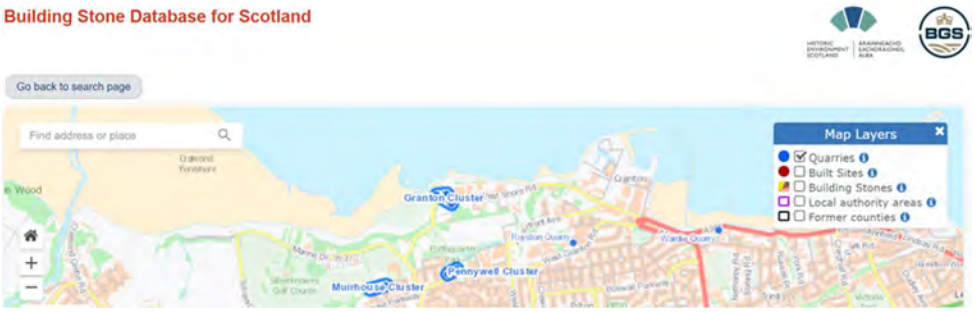


Figure 13: Quarry locations in and around Granton (British Geological Society 2023)

The Building Stone Database for Scotland contains information of previous stone samples. The records for Granton are:

- Granton Harbour Middle Pier, West Breakwater and East Breakwater are known to have been constructed from Gullane Sandstone from Granton Sea Quarry.[3]
- Old Granton Parish Church is known to have been constructed from a Lower Limestone Foundation Stone from Fordell Quarry.[4]
- Granton Parish Church (1936) is known to have been constructed from Kinnesswood Sandstone from Craigmillar Cluster.[5]

The sandstone used for Granton Parish Church has a pinkish hue, which is different from most of buildings in the Granton Waterfront area.

CARBONIFEROUS	Viséan	Strathclyde Gp	West Lothian Oil-Shale Fm	*Binny Sandstone*: Binny; Hermand; Humbie; Hopetoun White; Craigton; Cockmuir; Dalmeny *Grange Sandstone*: Grange; *Newbigging; Dalachy; Cullalo *Dunnet Sandstone*: Hopetoun *Hailes Sandstone*:Hailes; Redhall *Ravelston Sandstone*: Ravelston No. 2
			Gullane Fm	*Craigleith Sandstone*: Craigleith; Maidencraig; Barnton Park; Ravelston; Granton; Bearford's Parks and other local quarries

Figure 14: Extract from the stratigraphy of Scottish sandstones used in Edinburgh’s buildings. (British Geological Society 2023)

[2] Hyslop 2004
[3] Granton Harbour, Middle Pier, West Breakwater And East Breakwater — Building Stone Database Scotland (bgs.ac.uk)
[4] Granton Old Parish Church — Building Stone Database Scotland (bgs.ac.uk)
[5] Granton Parish Church — Building Stone Database Scotland (bgs.ac.uk)

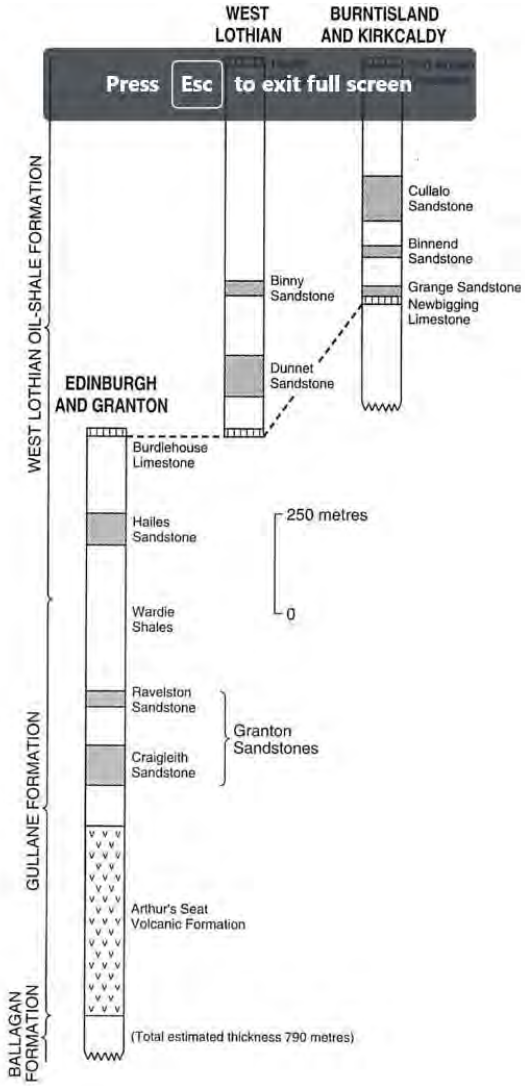


Figure 15: Generalised vertical sections in the Strathclyde Group of Lothian and Fife (British Geological Society 2023)

Immense Stone.—The largest stone which we believe has ever been cut out from any of the fine freestone quarries which abound in our vicinity, has been this week removed from the Duke of Buccleuch's quarry at Granton. It is a block of thirty tons weight of liver-rock, and is intended to form the statue of Lord Nelson, about to be erected in Trafalgar-square, London. It was yesterday removed from the quarry to Granton Pier, to be shipped in a vessel sent down specially by the Admiralty, for the purpose of conveying it to London. The labour of removing it from the quarry was great in proportion to the ponderous mass; but under the superintendence of skilful engineers was satisfactorily accomplished. The cost of the block, with the expense of placing it in Trafalgar-square, we have been told, will exceed 300*l.*—*Caledonian Mercury.*

Figure 16: Text extract noting the use of stone from Granton Quarry for the statue on top of Nelson's column

Figure 17: Extract from map dating from 1840-80 showing the Granton Quarry Location to the west of Granton Castle [Georeferenced Maps - Map images - National Library of Scotland (nls.uk)]

Brick

From the mid-1800s brick started to be more commonly used in Scotland as a construction material and the Duke of Buccleuch brought innovation in brick making to Granton and Smeaton brickworks:

02/05/1849 – North British Agriculturist – … In Scotland, even where stone of the very best quality is abundant, the manufacture of bricks is rapidly on the increase; and, strange as it may appear, notwithstanding the heavy excise duty on them. houses, garden walls, &c., can be built in many parts of Scotland cheaper of bricks than of stone. We take some credit to ourselves for improving the quality of bricks prior to 1839, when, through the liberality and anxiety ever evinced by the Duke of Buccleuch, for introducing improvements into his native country, we brought English brickmakers and bricklayers into Scotland. It is a notorious fact that, up to that period, there was not a brick of proper mould or quality to be had in this country. The example shown at Smeaton and at Granton has rapidly spread through the country …[6]

There were many brickworks around the central belt and during our site visit we found many bricks with the name of the brickworks printed on them. Namely:

- Granton Brick and Tile Works - Granton Brick and Tile Works appears on a map dated 1849-53 which was around the same time as the construction of the harbour development and Granton Brick Company Limited was struck off the company register in 1939.
- Smeaton – 1830 Smeaton Firebrick Works.
- Niddrie Fire Clay Works – Thought to have been established circa 1870.
- Niddrie Brickworks - Constructed in 1924, Niddrie Brickworks, near Edinburgh, was a large common brickworks built in 1924. It is thought that Niddrie Brickworks closed in the early 1990s.
- Whitehill Collieries and Brickworks – 1861- circa 1975 near Rosewell, Midlothian.
- Dewar bricks
  - 1896 P and R N Dewar, Cardonald Brickworks, Govan
  - Circa 1895 Dewar and Findlay Ltd, Drumpark Brickworks, Bargeddie

[6] Smeaton Firebrick Works, Newfarm, Dalkeith, Midlothian. | Scotland's Brick and Tile Manufacturing Industry (scottishbrickhistory.co.uk)

- Circa 1925 Shettleston Colliery Brickworks, Shettleston Glasgow
- Dennis Ruabon – Ruabon Brick & Terra Cotta Ltd.
- Dougal Winchburgh – Circa 1867 Winchburgh Brick, Tile and Fire Clay Works, Winchburgh, West Lothian.
- Camps – Circa 1870 Camps Lime and Brick Works, Wilkieston, West Lothian.
- GISCOL – Stands for Glasgow Iron and Steel Company (Limited).
- ETNA – Circa 1892 Etna Brickworks, Bathville, Armadale, West Lothian (likely source of specials found in Walled Garden).

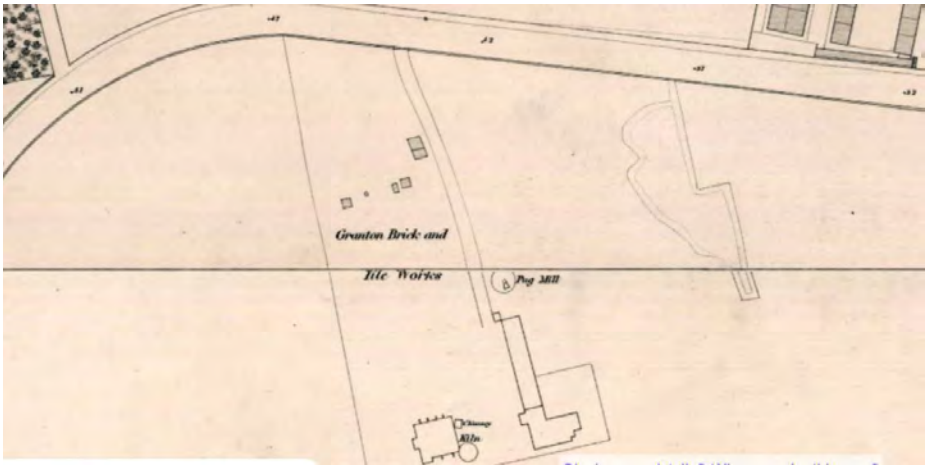


Figure 18: 1849-1853 – Granton Brick and Tile Works Georeferenced Maps - Map images - National Library of Scotland (nls.uk)

Slate

Metamorphic slates are used for roofing purposes and were primarily obtained from quarry sources around Ballacullish, Easdale in Argyll, the Macduff area in the north-east and along the Highland Boundary Fault. The colour of Scottish slates is generally grey, but colour can vary depending on the iron and carbon content of the slate. It is likely that the Scottish slates in Granton came from one of the quarries above.

We noted that some roofs in the Granton Waterfront area have been replaced using re-claimed Scottish slate, Welsh slate, and some Spanish slate.

Scottish slate roofs are laid differently to those elsewhere in the UK for two main reasons:

- High levels of wind driven rain requiring steeper pitched roofs, of 40 degrees minimum; and
- Small and variable sized slates produced by quarries.

Slates were usually single nailed which enables slates to be swung aside to inspect the nails on the courses below. The lighter weight of Scottish slate allows for single nailing, however, where slates are being replaced by heavier Welsh or Spanish slates they should be cheek nailed. Scottish slate roofs are also laid in diminishing courses, with the largest slates laid at the eaves level and gradually reducing in size so the smallest slates are used at the apex.

Description Photograph from evaluation, watching brief and standing building survey, Granton Harbour
Date 10/2003 to 12/2008
Collection Records of CFA Archaeology Ltd, archaeologists, Musselburgh, East Lothian, Scotland

Figure 19: Niddrie brick found in Granton Harbour (Canmore 2008)

Description Photograph from evaluation, watching brief and standing building survey, Granton Harbour
Date 10/2003 to 12/2008
Collection Records of CFA Archaeology Ltd, archaeologists, Musselburgh, East Lothian, Scotland
Catalogue Number DP 138360

Figure 20: Prestongrange brick found in Granton Harbour from Prestongrange Brick, Tile and Fireclay Works, Prestonpans, East Lothian (Canmore 2008)

5. Detailed narrative on specific buildings/ structures

5.1 Granton Castle Walled Garden

Listed Building Entry

Listed Building Reference: LB28139

Category B Listed

Date first listed: 1970

Description

Granton Castle Walled Garden is located to the west of the Granton Waterfront area, south of the shoreline and situated between Caroline Park to the east and the Social Bite Housing to the west

Figure 21: Granton Castle Walled Garden (Historic Environment Scotland 2023)

History

Granton Castle (originally Granton House) was built for John Melville of Carnbee from the late 15th Century. It was then reputedly ruined circa 1544 during the Earl of Hertford's local insurgences and later restored for occupation. Sir Thomas Hope of Craighall acquired the castle and carried out significant alterations and the garden was mentioned in diaries kept by Sir Thomas Hope of Craighall. In 1740, John Campbell the 2nd Duke of Argyll bought the castle, a year after he purchased Royston House and its estate. John Campbell almalgamated the two baronies of Easter and Wester Granton to form a large estate which was named Caroline Park, after his daughter Caroline who was married to the son of Buccleuch.

In 1740 – 1760, there was significant development of the gardens and landscape at Caroline Park, which included the incorporation of the walled garden into an elaborate planned estate landscape. From 1760 Caroline Park House was leased and, following Lady Caroline's death in 1794 fell into the ownership of the Buccleuchs. Various parts of the estate were sold off from the late-1800s.

Figure 22: Map dating from 1834 – Granton Castle and Walled Garden evident.

Granton Castle was also leased out for a brief period until the late 18th Century when it became disused and soon fell into ruin. The castle was designated as a Scheduled Monument in 1920 but was subsequently demolished in 1921 after it had been undermined by quarrying.

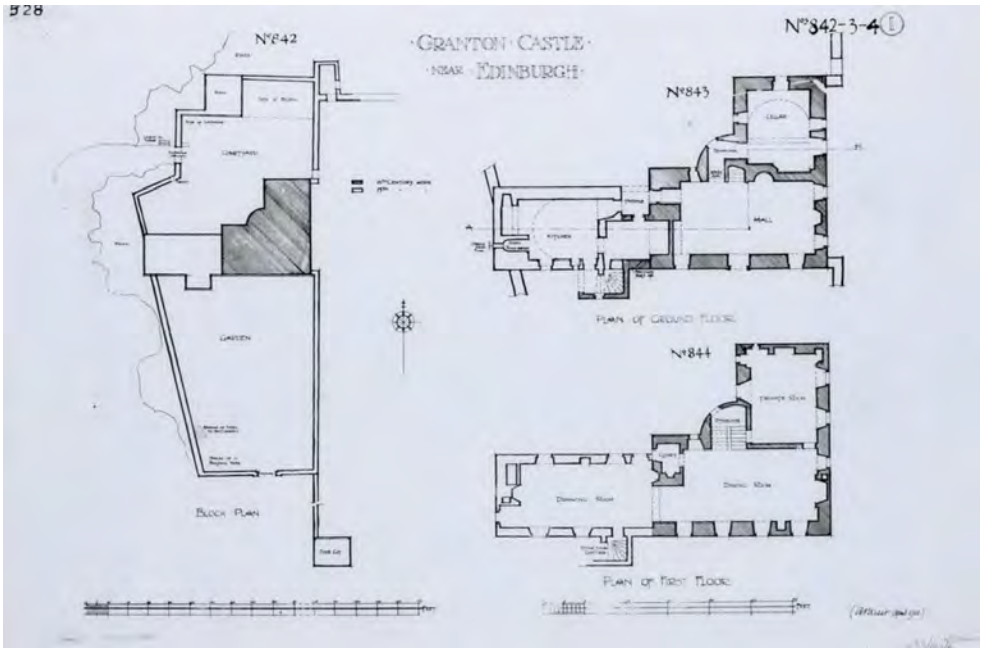


Figure 23: Block, ground and first floor plans of Granton Castle, 1901 (Canmore 2023)

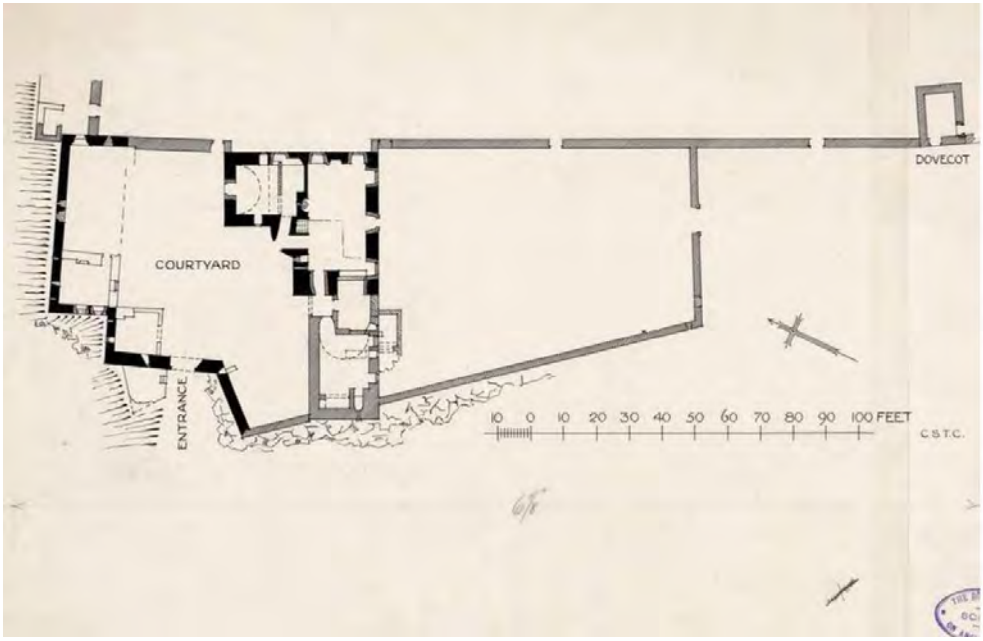


Figure 24: 1920 Publication Drawing – Granton Castle (Canmore 2023)

Figure 25: View of men digging beneath Granton Castle in 1890 (Canmore 2023)

Figure 26: Granton Castle, view from south with washing and chickens in courtyard (Canmore 2023)

Figure 27: View of Granton Castle, c.1900 (Canmore 2023)

From the early 1800s, the parkland estate surrounding Caroline Park House diminished due to the increasing industrial interests of the Buccleuchs, which included Granton Harbour, the quarry to the shore, the railway connecting Edinburgh to Perth via Granton and the large gasworks to the west from the late 1800s.

The most significant changes to the walled garden were the construction of two long glass houses built in the early 1900s.

Significance

The doocot, boundary wall and walled garden are *early surviving examples of their building type and remain important ancillary components of a significant 17th century house and to some extent, its later estate landscape. The pre-18th century footprint and fabric of the garden walls forming a castle/garden enclosure and the survival of the doocot is of interest.*

The walled garden, doocot and boundary wall was originally built as part of the former Granton Castle, which was demolished in 1921. It is likely that come of the fabric of the castle's former east elevation is incorporated in the walls of the walled garden. The castle fell into disuse and the walled garden and doocot became ancillary buildings for Caroline Park House, which is one of Scotland's most important surviving 17th Century Houses.

Walled gardens are important ancillary structures of high-status country houses and was particularly important in Scotland due to the unfavourable growing conditions and evolved as part of the typology of the fortified Scottish castle.

Dovecotes (doocots in Scotland) provided shelter and protection from vermin to nesting pigeons and mostly feature in early gardens. Doocots largely ceased to be built after the mid-19th century when the need for them diminished.

The doocot at Caroline Park/ Granton Castle appears on 18th Century estate maps and is of particular interest for its age as pre-18th century examples of surviving doocots are rare.

Figure 28: Doocot at Granton Castle Walled Garden (Canmore 2023)

The glasshouses which survive to the south elevation of the north wall date from the late 1800s/ early 1900s and are of standard design and construction for their date and are not considered of special interest in listing terms.

Identification of the material types and varieties

North Wall

- Mostly blonde sandstone rubble with ridged sandstone coping, with some areas covered in white painted render.
- Whilst on site we were advised that repairs had been ongoing recently, which appears to have included repointing to the elevations and a cement capping to the wall. It is unclear as to why cement has been chosen for the wall capping. The specification for the repairs has been provided by the client and is included in Appendix A.
- Grey sandstone lintel and rusticated quoins to doorway.
- To the midpoint there are some flat grey sandstone rectangular coping slabs bonded by cement which is presumed to be a later addition.
- Brick chimney and walls – assumed to be part of Victorian glasshouses.

- Concrete cornice is assumed to have once supported other lean-to structures.

East Wall

- Mixed sandstone and greywacke sandstone rubble bonded with lime mortar.
- Later repairs of roughly rectangular shaped re-used stones bonded by cement mortar.
- Two bricked walls with flat rectangular roof forming a small shed.
- To the southern end a building was built against the wall, which forms part of the outbuildings associated with Royston House (Caroline Park) which consists of 'Granton' brick walls to the north, east and south and a brick wall on top of the stone wall. Bricks laid in Scottish Bond (headers then 5 courses of stretchers then headers).

South Wall

- Mixed sandstone and greywacke sandstone rubble bonded with lime mortar.
- Areas of cement pointing towards western end.
- Rectangular stone lintel and quoins to doorway.

West Wall

- Blocks of sandstone, upper sections repointed in cement mortar.
- Approximately 38m of wall to the northern section, where the castle once stood, was removed during quarrying.

Internal Stone Wall Running East-West

- Mixed sandstone and greywacke sandstone rubble, bonded with lime mortar.
- Some sections of wall have been reinforced or repaired with cement mortar and reused carved stones (probably from castle ruins).
- Later brick extension on top of western section of wall, probably associated with the greenhouse structure.

Dovecot

- 'lectern' style dovecot of rectangular floor plan, 3 storeys high.
- Single pitch slate roof slanting to south – replaced in 2016 with re-used Scot's slates (specification provided by client Appendix B).
- Worked sandstone blocks of various sizes and corner quoins with crowstepped detail visible to east and west gables.

- Each floor is separated by elongated blocks of sandstone forming a rat course.
- Door framed by sandstone quoins.
- Recent concrete and brick repairs evident.
- Single course of brick at eaves level indicates a later repair.

Greenhouse walls

- What is left of the Victorian greenhouses are the brick walls and some timber to the north wall.
- To south elevation of north wall – Scottish bond, Niddrie red facing bricks.
- To centre – Scottish Bond, Dougal Winchburgh red facing bricks (headers then 5 courses of stretchers then headers).

Material Testing and Analysis

Whilst on site we conducted a visual analysis of the materials to determine what they are and where they came from.

Whilst on site we took one available sample of stone and delivered it to the British Geological Society for testing and analysis. This analysis determined that the sample was likely from the Gullane Formation from Granton Quarry. The full report, including recommendations for closest matching stone from open quarries is included in Appendix F.

Identification of where the material may originally have come from

Stone

It is likely that both the blonde sandstone and greywacke stone came from one of the quarries which were located in the Granton vicinity. Due to the proximity of Granton Castle Walled Garden to Granton Quarry, we consider it highly likely that the stone was sourced from there.

Bricks

Whilst on site we found a range of bricks, including Niddrie, Dougal Winchburgh, Giscol, ETNA, Smeaton and Granton. The Granton bricks were located in an outbuilding in the east wall, adjacent to Caroline Park House and have varying surface colour which leads us to believe that these may have been colliery bricks. The other bricks found on site are either part of the remaining greenhouse walls or were found around the site. These bricks have a more consistent colour and texture suggesting they were made from pure clay. In addition to this we found some special bricks and it is unclear whether they have come from another site or were part of the walled garden construction. The special bricks look similar to other ETNA specials found on the Scottish Brick History website.

Lime Mortar

Due to the presence of seashells in some of the lime mortar on site, particularly to the boundary walls, it is likely that the sand for the lime mortar came from local beaches and that crushed shells were used as an additive.

Slates

The roof to the Doocot was replaced in late-2016 and according to the specification, second hand reclaimed Scottish slate was used in diminishing courses. Re-claimed slates often come from buildings which are being demolished or are having their roof replaced. The quality of the slate depends on their age and weathering.

Recommendations for matching the material from currently available sources for repair

The number of active quarries in Scotland has greatly reduced due to the lack of demand caused by the increased use of concrete from the late 19th Century. Therefore, it may be necessary to source a match for stone repair from England. The stone samples taken should inform which stone is a best match for the existing stone. It is important that stone is not just matched on visual qualities but is also matched in terms of porosity and composition.

The brickworks mentioned above are no longer in operation, and therefore an alternative solution is required. When selecting new or replacement brickwork, it is important to analyse a sample of the original brickwork to understand its composition and porosity. It is also important to match the colour of the new bricks to the old. Once the results of the analysis have been received, either a reclaimed brick or new brick can be specified. We would recommend obtaining a sample of the new brick prior to placing an order.

It is expected that the lime mortar to the Garden Walls was made using locally sourced materials, for example sand and shells from the beach. However, we would recommend sending a sample of lime mortar to the Scottish Lime Centre for testing. The greenhouse walls were constructed at a later date and as such will likely have a different lime mortar mix. Later cement mortar repairs should not be replicated.

Condition of materials

The solid masonry walls are all in varied states of repair. The north wall has recently been repaired to the specification in Appendix A. The specification includes for a cement mortar to the capping which varies from the original lime mortar. The other walls have had previously inappropriate cement repairs carried out. The brick walls to the Victorian glasshouses are in a poor state of repair, with loose bricks and mortar.

The doocot had its roof replaced in 2016 and as such is in fair condition however, there is vegetation growing out of some on the mortar joints which will be allowing mortar ingress.

The condition of the walls and doocot are considered to have been caused by a lack of ongoing maintenance, rather than an inherent defect in the materials used or location of the walled garden.

Recommendations for repair/maintenance.

The walls to the Walled Garden are all in varying states of repair, with the north wall having been recently repaired and other walls requiring repairs. We would recommend that the walls are prioritised in order of poorest condition to best condition and that a 10 year planned maintenance schedule is created to ensure that repairs are planned, and budgeted for, well in advance. Regular maintenance, such as removing any vegetation, re-bedding any individual loose bricks or stones and refixing any slipped slates to the Doocot should be scheduled on an annual basis.

We would recommend that when undertaking repair works specific stone, brick and/ or lime mortar samples are taken and sent for analysis to provide accurate information to inform the specification for repair. We would then recommend obtaining samples of the materials and completing sample panels, or repairs, for review and sign off by the local conservation officer. When repairing masonry walls it is recommended to use hand tools, rather than power tools and to ensure that the work is adequately protected from the weather.

5.2 Granton Lighthouse (Northern Lighthouse Board Engineering, Storage and Testing Facility, including Outhouses)

Listed Building Entry

Listed Building Reference: LB29925

Category C Listed

Date first listed: 20th February 1985

Description

Granton Lighthouse is located at 22 West Harbour Road and is the former Northern Lighthouse Board Engineering, Storage and Testing Facility, now used as accommodation for small businesses. It consists of a 2 storey, 15-bay warehouse with corner tower surmounted by a lighthouse lantern cupola and a single storey outhouse range to the east of the yard. It was constructed in the late 1800s with the lighthouse was added in 1874. It was then altered in the early 20th century, which was when the upper most floor was added.[7]

History

[7] Granton Lighthouse Depot · (lighthouseaccommodation.co.uk)

The Northern Lighthouse Board Engineering, Storage and Testing Facility was constructed in the late 18th Century on land leased from Walter Montagu Douglas Scott, 5th Duke of Buccleuch in 1852.[8] It was used to store equipment for the Northern Lighthouse Board's lighthouses until 2001 when operations were relocated to Oban. From the late 18th Century to the late 19th Century the lighthouse tender NLV Pharos was berthed in Granton Harbour and would transport supplies from the depot to the Northern Lighthouse Board's lighthouses and transport used or empty items back to the depot.

On site there was an administration office, warehouse and workshops[9] and equipment such as buoys were serviced at the depot. The lighthouse tower was never an operational lighthouse but was used to test lamps and other equipment. The engineer John Richardson Wigham was invited to the depot in 1869 to demonstrate an experimental gas lighting technique. A coal gasworks was constructed at the depot to produce the fuel for Northern Lighthouse Board's beacons and light buoys but was removed in the 1930s after coal gas was replaced by acetylene. In 1907 a railway siding and overhead crane were added. The Canmore record for the lighthouse depot states that it was reported that one of the glass panes in the lantern had a bullet hole from machine gun fire from a German (Luftwaffe) aircraft after the outbreak of WWII.[10]

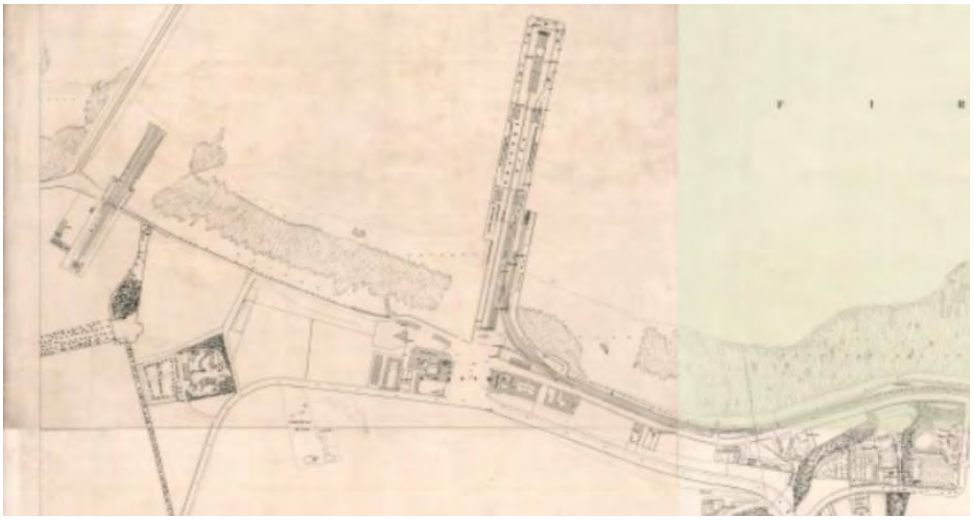


Figure 29: Map from 1849-53 showing no Northern Lighthouse Engineering, Storage and Testing Facility in the existing location (National Library of Scotland 2023)

[8] Granton Lighthouse: Overview of Granton Lighthouse (archive.org)
[9] Heritage Locations (nationaltransporttrust.org.uk)
[10] Edinburgh, Granton, 22 West Harbour Road, Northern Lighthouse And Buoy Depot, Workshops And Leading Light | Canmore

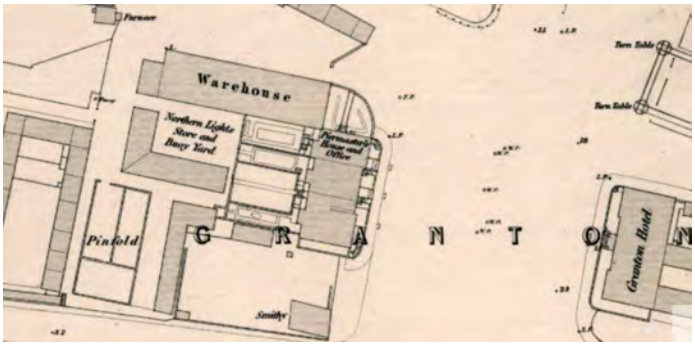


Figure 30: Detail of 1849-53 map with Northern Lights Store and Buoy Yard shown across from the Granton Hotel (National Library of Scotland 2023)

Figure 31: 1876-1877 Map showing the Northern Lighthouse Engineering, Storage and Testing Facility in the existing location (National Library of Scotland 2023)

Figure 32: Close up of 1876-1877 map – note the edge of the building is square to the northeast of the main store, not chamfered as it is today (National Library of Scotland 2023)

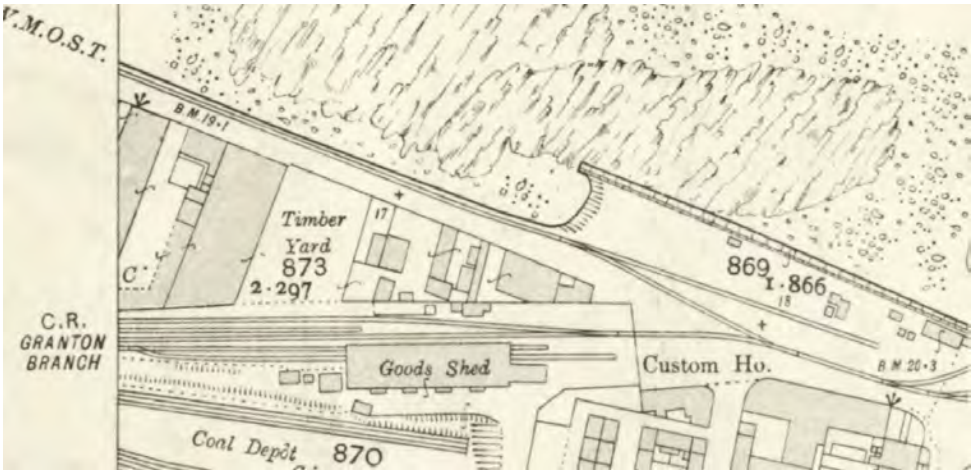


Figure 33: Map from 1912 showing the square edge to the northeast of the store. Note the Timber Yard, Goods Shed and Custom House.

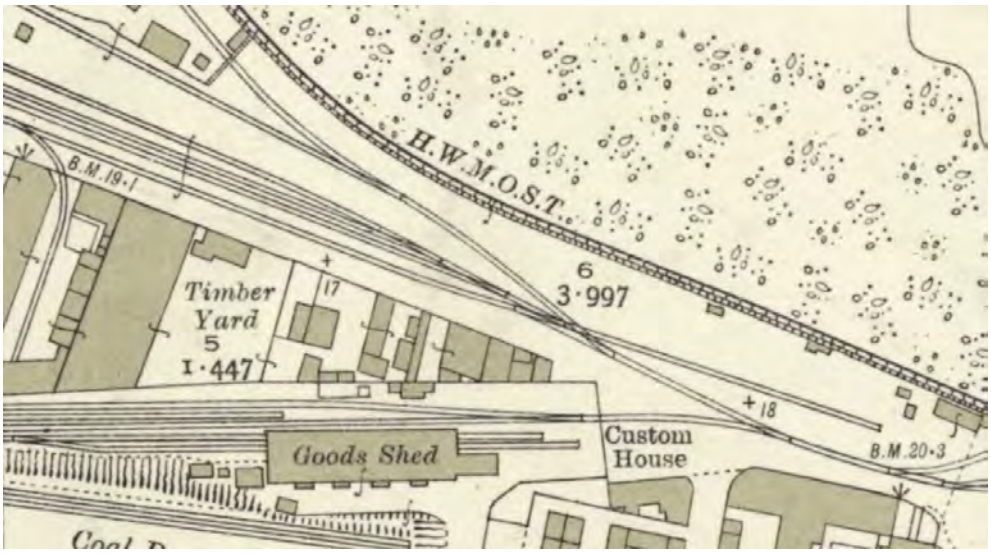


Figure 34: Map from 1931 showing the chamfered edge to the northeast of the store as it is today.

Significance

Built as part of the 'Northern Lighthouse Stores and Buoy Yard' (as 20 West Harbour Road), the complex has remained largely unaltered from when it was altered to add the first floor. Its proximity to the harbour is significant as this was where the tender NLV Pharos would be loaded with supplies to take to the remote lighthouses. The lighthouse cupola is significant as this is where experimental lighting tests were undertaken.

Identification of the material types and varieties

The roof coverings on the pitched roofs are mostly traditional Scotch slates laid in fairly regular courses on the main building, whilst on the outbuilding, given their size and thickness, seem to be Welsh slates. From what can be observed from ground level and vantage points, flat roofs are currently covered with bituminous roof felt but it can be assumed they were originally lead. Central tapered gutters could not be seen during the

inspection but it is assumed to be the same. Roof flashings are a combination of lead and zinc, the latter possibly of later replacement. The rainwater goods to the main building are cast iron half round gutters and downpipes. To the outbuilding the rainwater goods have been replaced with uPVC half round gutters and downpipes but these are presumed to have originally been cast iron.

The steel lattice framed glazed dome to the lighthouse has a copper domed roof which appears to have been covered in a bitumastic material, presumably as a temporary repair measure.

The walls are of solid brick construction, laid in an English Cross or Dutch bond, bedded and pointed with lime mortar. Constructed of red bricks with yellow brick angle dressings to windows and door openings and stone window cills. Dewar and Dennis Ruabon bricks were found at the base of the building, however, we have not confirmed if these are related to the lighthouse. The outbuilding walls are of solid brick construction laid in an English Cross or Dutch Bond, bedded and pointed in lime mortar. Mostly of red brick construction with white brick angle dressings. On site we removed a white brick (240x80) and it had a WHITEHILL stamp. The garden walls are constructed of Niddrie bricks laid in a stretcher bond with concrete cappings. More recent cement mortar repairs are evident which are causing degradation of the brickwork.

There are cast iron columns to the outbuilding, some of which are surrounded by brickwork and others supporting structural openings.

Identification of where materials may have come from

The slates to the main roof are likely to have come from one of the four slate quarries which used to operate in Scotland. As there are no slate quarries operating in Scotland currently, replacement slates will either have to be re-claimed Scottish slate or a compatible Welsh slate such as Siga 120. When matching the slate it is important to assess the weight, colour, texture and sheen. The roof to the outbuilding appears to be Welsh slate, and as such, if replacements are required, we would recommend using a Welsh Penrhyn, Cwt-y-Bugail or Ffestiniog slate.

For the lighthouse lantern, it is not known where the copper sheet was sourced from. We would recommend replacing the copper sheet with copper sheet closely matching the original overall appearance but with details recommended by the Copper Development Association. A new copper roof will alter the appearance of the lighthouse until patination takes place.

Cast iron rainwater goods in the area all have the same hallmark and appear to be from the same foundry. If replacement is required, they should be replaced with cast iron gutters and downpipes in matching profiles.

Whilst on site we carefully lifted a loose red brick to the head of the wall of the main building, however, there were no markings. The red bricks measure 230 x 75mm. There were no appropriate areas to remove a yellow brick from the main building. The yellow bricks measure 240 x 80mm. It was not possible to determine where the red bricks to the outbuilding were from but the white bricks are 240 x 80mm from Whitehill Brickworks. The garden wall is constructed from Niddrie bricks. As none of the aforementioned brickworks are still in operation, it is recommended that, where replacement is required, bricks are sent for testing to analyse their pore structure and composition. Once this is complete, a brick of matching composition, colour and size can be specified.

Lime mortar is likely to have used local aggregates, and there may have even been a local lime kiln. Prior to preparing a specification, we would recommend sending the mortar for analysis to the Scottish Lime Centre to understand the mix.

Condition of materials

From our inspection, it is evident that there has not been any significant building repairs or maintenance carried out recently as the lighthouse building is in relatively poor condition. From ground level the roof looked to be in fair condition with some slipped slates visible. The coating to the copper domed roof to the cupola is significantly worn and, although close visual inspection was not possible, it is expected that the copper sheet has deteriorated, possibly accelerated by the marine environment. The cast iron rainwater goods are in varying states of repair with corrosion and cracking to joints visible. The brick walls are in fair condition, however, there is evidence of cement repointing which is causing sacrificial damage to the bricks. The windows are in a poor state of repair, with some boarded, other panes cracked or missing and timber decay evident due to a lack of regular maintenance. The timber doors are in a similar state of repair due to a lack of regular repairs and redecoration.

The outbuilding is also in a poor state of repair, however, from ground level, the roof looked to be in fair condition with only isolated slipped slates. There is a missing downpipe to the southwest corner of the building. The brickwork has been repointed using cement mortar which has caused significant damage to the brickwork, with bricks being eroded and crumbling when touched. The timber windows have been boarded up and it was unclear whether the timber doors are operational.

The garden wall is in a poor state of repair with loose sections of brickwork.

Although the lighthouse is near the sea, its location is mostly sheltered, with the cupola and north elevation being the most exposed. The overall condition of the lighthouse buildings is considered to be the result of a combination of a lack of ongoing repairs and maintenance and vandalism.

Recommendations for repairs/ maintenance

The Lighthouse and Outbuilding require repairs to the roof, rainwater goods, masonry and joinery in the near future to put them back into good condition.

Prior to undertaking any repairs or maintenance, we would recommend obtaining a sample of the stone and lime mortar which require repair. The samples should be sent for testing to the British Geological Society or Scottish Lime Centre. Once the origin and composition of the materials has been ascertained, samples should be produced for approval by the local conservation officer.

The slates to the main building appear to be Scottish from ground level and the slates to the outbuilding appear to have been replaced with Welsh slates. When repairing or replacing the slate roofs, we would recommend trying to find as close a match for the existing slates, such as Burlington Blue Greys, Siga 120 or Cupa H3.

Once the building is in a good condition, a planned maintenance schedule should be created for the Lighthouse and Outbuilding to ensure that routine maintenance tasks, such as removing vegetation, clearing gutters, etc. happen on a regular basis. This will

prevent the building from falling into disrepair and will allow small defects to be dealt with before they become much larger.

Figure 35: View of lighthouse from West Harbour Road, 1975 (Canmore 2023)

Figure 36: View of lighthouse and adjacent store from West Harbour Road, 1975-76 (Canmore 2023)

Figure 37: West Harbour Road, Granton 1979 (Canmore 2023)

5.3 Granton Station

Listed Building Entry

Listed Building Reference: LB45794

Category B Listed

Date first listed: 10th November 1998

Description

Granton Station is located to the south-west of the Granton Waterfront scheme area at 1 Granton Station Square, Edinburgh EH5 1FU.

The station was designed by W R Herring in 1898-1904 with later alterations in the 20th Century. It is a 2 storey, 7 bay rectangular former railway station and office block for the Granton Gasworks. It is of plain Edwardian, classical design with a baroque pediment. The walls are of red brick with contrasting yellow brick and buff ashlar sandstone dressings. The bays are divided on all sides by yellow brick pilasters with fluted ashlar capitals and slightly projecting red brick pedestals with ashlar coping and a red brick entablature above the ashlar architrave and eaves cornice. Yellow brick basket arches to ground floor windows and stone sills throughout.

Grey slate piended roof with single red brick wallhead stack with stone dressings, including coping. Lower section curved like Baroque pediment.

The railway platform adjoins the building, running north-south from the side elevations. Constructed of engineering brick sides with projecting concrete kerb blocks. The surface has been asphalted and is covered in building debris at present.

History

Granton Station is one of the last surviving elements of the expansive Granton Gasworks. The other being the Gas Holder which is currently undergoing refurbishment by the client.

Opened on 27th February 1903, the original purpose of the building was to transport the workers arriving my steam train, with a bridge providing a route across the numerous freight tracks. The internal system of narrow-gauge lines used steam locomotives to transport coal to the gasworks and transport ashes and other waste products from the site.

The building was designed to accommodate a stationary train within its form allowing workers to alight undercover onto the platform and circulate up to an upper level via an internal stair, leading to an iron bridge spanning over the freight tracks.

A distinctive clock is located centrally on the west elevation directly above the original footbridge entrance, which has since been partly infilled and replaced with a window.

The design is accredited to engineer, W. R. Herring who designed many of the Gasworks buildings including the surviving gas holder.

When it was built, the railway station provided the only means of transport for many of the gas-workers. The advent of the roads in later years along with improved local connections led to the closure of the station in 1943.

The station building was repurposed by the gas company as administrative offices and has undergone a number of significant alterations, including masonry infills incorporating un-sympathetic windows and doors to many of the original openings. The building was used as administrative office space until the early 1990s.

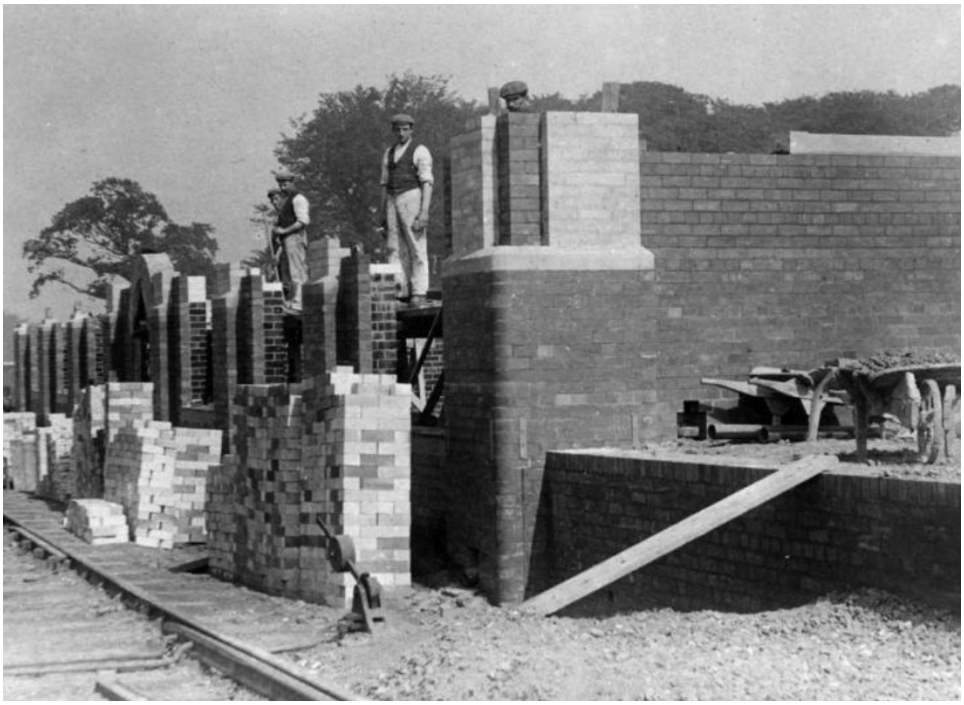


Figure 38: Construction of Granton Station 1901 (Canmore 2023)

Figure 39: Workmen alighting train at Granton Gasworks Railway Station, 1909 (Canmore 2023)

Figure 40: General view of railway station building and footbridge, with machine shop in background, Granton Gasworks, Edinburgh 1906. (Canmore 2023)

Figure 41: View of Granton Gasworks Railway Station covered platform. (Canmore 2023)

Figure 42: Rear of Station Building, 1998 (Canmore 2023)

Figure 43: Clock to station buildng having suffered storm damage, 1998 (Canmore 2023)

Significance

The station is significant as it is one of the few remaining buildings from Granton gasworks. It is also unusual as it contained an internal route for workers to clock in and out and travel across the bridge (now missing) to the gasworks. In addition to this, it is

considered a good example of stately corporation architecture applied to an industrial site.

Identification of where materials may have come from

The station has recently undergone a full refurbishment, including repairs, however, we have been unable to obtain details of the materials used for repairs/ replacements. From our visual inspection on site, we have made the following assessment.

Roof coverings on the pitched roofs are typically traditional Scottish slates laid in diminishing courses. Roof flashings are lead and rainwater goods are ogee profiled cast-iron gutters with round downpipes.

The walls are of solid red brick construction laid in an English Garden Wall Bond with yellow brick columns and arches above ground floor windows. At first floor there is a yellow sandstone detailing around the clock face, cornice and window mullions and transoms. The very fine joints in the brick and stonework are pointed with lime mortar.

The platforms are constructed of red brick with concrete kerb stones and red engineering bricks. ETNA and COLTNESS bricks were found on site.

The windows and doors have been replaced with double glazed powder coated aluminium units and the platform has been infilled to provide office accommodation.

Internally there are cream-coloured glazed bricks, however, we were unable to determine the origins of those bricks.

Recommendations for matching materials from currently available sources for repair

It is unclear whether excess slates were purchased during the refurbishment project to use to replace any slipped or damaged slates. If not, it is recommended that reclaimed Scottish slates are used for isolated repairs. If full replacement was required, an alternative slate may have to be used given the limited number of reclaimed Scottish slates available.

If replacement of the cast iron rainwater goods is required, they should be replaced with cast iron gutters and downpipes in matching profiles.

As ETNA and COLTNESS brickworks are not in operation, it is recommended that, where replacement is required, bricks are sent for testing to analyse their pore structure and composition. Once this is complete, a brick of matching composition, colour and size can be specified. It is unclear whether this was carried out during the refurbishment project but if it was, this information should be recorded and kept on file for future repairs.

Lime mortar is likely to have used local aggregates, and there may have even been a local lime kiln. Prior to preparing a specification, we would recommend sending the mortar for analysis to the Scottish Lime Centre to understand the mix. Again, this may have been undertaken for the refurbishment project but we have not received any records.

Condition of materials

The building has just undergone a full repair and refurbishment project and as such is in good condition. We understand from the client that the roof was replaced/ repaired ahead of the refurbishment project. The platforms were excluded from the project, and as such require some repairs to the brickwork and concrete kerb stones. There are isolated missing bricks to the walls and areas of missing mortar. The concrete capping stones are in varying states of repair, with some spalling evident. There is vegetation growth to the upper surface of the platform, which has had rubble scattered on it.

Recommendations for repairs/ maintenance

The station platforms require some repair work to put them into a good state of repair. We would recommend removing the rubble to the top of the platform to allow a full assessment of the condition of the platform. Subsequently, we would recommend raking out defective mortar using hand tools and repointing the brickwork using a suitable lime mortar. Where bricks are missing, we would recommend that they are replaced with an engineering brick of the same size and matching colour and texture.

A regular maintenance plan should be implemented to maintain the platforms and remove vegetation growth as they are a significant part of the readability of the station building and its historic use.

Figure 44: Ordnance survey map from1906 with the Granton Gasworks Railway Station visible. (National Library Scotland 2023)

5.4 Madelvic House

Listed Building Entry

Listed Building Reference: LB45654

Category B Listed

Date first listed: 16th September 1998

Description

Madelvic House was constructed in 1899 and is a two-storey building, originally with 3 symmetrical bays but now extended by one bay to the West and 3 bays to the East. Red brick with red sandstone dressings and a grey slate roof. The ground floor is advanced with a balustraded parapet forming a balcony to the first floor. The windows are architraved and there are long and short angle quoins. The main doorway is pedimented and pilastered with the symbol of Madelvic Motor Carriage Co. Panelled door with single window to first floor above. Bipartite windows in flanking bays, pediments to first floor windows. 2 storey, single bay flat roofed extension in similar style. Higher 2 bay extension with bipartite windows and there is a stone mullion missing to the west window on the first floor. There is a later gabled porch to the east elevation. The rear elevation has irregular fenestration.

History

Madelvic House was the original office of The Madelvic Motor Carriage Company which was founded in 1898 by William Peck. Madelvic was one of the first Scottish motor brands built in the first British purpose-built car factory. After the company was liquidated in 1900, a string of other vehicle manufacturing companies used the factory, including Kingsburgh Motor Company, Stirling's Motor Carriages LTD, Scottish Motor Works, and the Scottish Motor Engineering Company. By 1912, vehicle production on the site ended and during WWII the factory was used for storing torpedoes. United Wire, a wirecloth manufacturer, moved into Madelvic House in 1925 and has been a part of the community for more than 175 years. Today, United Wire's factory and offices are across the street from Madelvic House.

Significance

The buildings designed for the Madelvic Motor Carriage Co Ltd are probably the earliest purpose-built motor works in Britain (Collins and Stratton). The company assembled battery-electric carriages propelled by a fifth central wheel on the road (as depicted above the entrance to the office). Madelvic went bankrupt in 1900, and the premises were first sold to the Kingsburgh Motor Construction Co, and then in 1902 to Stirling Motor Carriages Ltd, which produced mainly buses and lorries here until 1912. The production block was described in 1903 as housing a machine shop, an erecting department for the engines, and all the sections for integrated coachbuilding. The buildings appear in original form on 1906 OS map, and with some extensions on 1938 OS map.

Identification of where materials may have come from

Roof coverings are generally traditional Scottish slates laid in fairly regular courses on the main building. Roof flashings are a combination of lead and zinc, also being the latter possibly of later replacement. Rainwater goods are predominantly traditional half-round cast iron gutters and round downpipes.

The walls are of solid red brick construction, laid in an English Garden Wall Bond with red sandstone skew copes, angle quoins and window architraves. Sample analysis

would be required to determine the exact source of the sandstone. Madelvic motors emblem above main doorway. 4 over 4 timber sash and case windows. Very thin joints pointed with lime mortar.

We found Coltness bricks on site but it is unclear where they came from.

Recommendations for matching materials from currently available sources for repair

If repairs are required to the red sandstone a sample should be taken and analysed by the British Geological Survey to determine its origin. The British Geological Survey will then recommend the best available stone to match the existing sandstone.

It is recommended that, where replacement is required, bricks are sent for testing to analyse their pore structure and composition. Once this is complete, a brick of matching composition, colour and size can be specified.

Lime mortar is likely to have used local aggregates, and there may have even been a local lime kiln. Prior to preparing a specification, we would recommend sending the mortar for analysis to the Scottish Lime Centre to understand the mix.

Condition of materials

From ground level the roof appeared to be in fair condition but there is vegetation growing out of the coping stones. The masonry is heavily soiled in areas and there is some erosion to window architraves and mullions which could be due to the red sandstone being more susceptible to erosion in a seaside climate. The painted masonry is in poor condition with peeling paint. The sandstone plinth has been replaced at a later date to main front elevation.

Aside from the erosion of the red sandstone, the visible defects at Madelvic House are considered to be from a lack of regular maintenance and repair, rather than an unsuitable choice of materials for the location and climate.

Recommendations for repairs/ maintenance

Madelvic House requires some repairs to the roof, rainwater goods, masonry and windows to put it back into a good state of repair. The slates appear to be Scottish, so we would recommend finding Scottish reclaimed slates to replace isolated cracked slates. Prior to undertaking any masonry repairs, we would recommend sending samples of the brickwork, red sandstone and lime mortar for testing by the British Geological Survey to ascertain the best match for repairs. Samples should be shown to the Conservation Officer for prior approval before undertaking the works.

A planned maintenance schedule should also be prepared to ensure items such as regular removal of vegetation, clearing gutters, replacing slipped slates, etc. are carried out on a regular basis which will help keep Madelvic House in good condition.

6. Summary

In summary, this materials audit has determined that the buildings and structures located in the Granton Waterfront Scheme Area have been constructed from similar materials. The majority of the surviving buildings were constructed in the 19th and 20th Centuries as Granton developed into an industrial area with its new harbour.

The roofs are generally pitched and covered in Scottish slate with lead flashings. Where pitched roof coverings have been replaced, they are generally re-claimed Scottish, Welsh or Spanish slates. Lead flashings have been replaced with zinc, presumably due to cost and the coastal location. The rainwater goods are generally painted cast iron with half round gutter profiles and round downpipes.

The walls are mostly of solid masonry construction of either sandstone or brick bedded and pointed with lime mortar. The sandstone has been assessed as being generally from the Granton and Edinburgh area, and, as there are no longer quarries operating in the Edinburgh area, a replacement sandstone would have to be sourced from an English quarry. The red and yellow bricks appear to be from a range of brickworks which were operating across Scotland in the 19th and 20th Centuries.

The Walled Garden is the oldest of the specified sites that we reviewed for the materials audit. Some of the walls are thought to have been constructed at the same time as the castle, and as such, the stone is expected to be from the local Granton area. The Doocot was reroofed in 2016 using reclaimed Scottish slates and is a good example of material matching during a roof replacement project.

Since the Lighthouse was altered in the early 1900s to add the first floor it has remained relatively unchanged and as such the original materials are still readable. The slight change in brick size from the alterations is visible, although the colours are well matched. The roof to the store looks as though it has been replaced with Welsh slates but they have been well matched to Scottish slates. The lighthouse cupola is an individual detail in Granton as copper has not been widely used for roofing.

The Station has undergone a full refurbishment project to repair the building and change its use to workspace, however, the platforms were not included in this project and as such are in need of repairs. They are constructed of engineering bricks with concrete kerbs and the top of the platform is currently covered in building rubble and weeds.

Madelvic House has been extended since its original construction, however, the externals of the main building have remained relatively unaltered. It is unique to Granton in that the stone detailing is red sandstone, rather than the typical blonde sandstone.

In conclusion, the materials used in Granton can be broadly described as Scottish slate, lead sheet, cast iron rainwater goods, sandstone, bricks and timber windows and doors. As it was not possible to sample all materials without causing unnecessary damage to the buildings, we would recommend specific materials are sampled and tested by the British Geological Survey prior to finalising the specification for repair.

APPENDICES

Appendix A. Granton Castle Walled Garden North Wall Repair Specification

Recommended mortar mixes:
The following specifications capture all the various requirements in terms of mortar mixes and application and curing regimes to be adopted.

Mortar type A	For bedding stone where necessary
Purpose:	To finish joints to plane, level and texture.
Masonry unit preparation:	Dampen individual units as required. Do not kill suction.
Mortar:	NHL 3.5 naturally hydraulic lime and local sharp Concrete Sand
Ratio:	(nominally by volume) 1 part binder to 2 parts sand
Mixing:	Add just enough water to achieve a stiff but workable consistency for bedding such that the mortar supports the masonry units without squeezing out unduly.
Application:	Where being used for finishing as building proceeds the excess mortar should be struck off the bed and cast or pointed back into a level plane of the face of the masonry units either by throwing and flattening off with a trowel or by placing with a trowel into hungry bed joints. Joints in masonry should not exceed more than 10mm without the use of pinning stones set in mortar as the build proceeds or well bedded where pinning for pointing work only. Use only pinning stones of a similar nature to the existing materials, (new replacement stone as stated may be cut, shaped or split from new blocks to provide suitable pinning stones).
Curing:	Cure with light misting with clean potable water such that the mortar does not fully dry at any time within the first three days, except where the walls may be damp, not wet, in which case the work should be covered only to avoid rapid drying on the face. Keep all work covered and ensure the top of the wall is under cover capable of protecting it from direct rainfall during the time when the site is unoccupied or when work is halted because of rain. Working in wet weather on an open wall head will not be permitted.

Mortar Type C	Re-bed and repoint coping stones
Purpose:	To provide fully filled joints to copes
Background preparation:	Carefully remove decayed extant mortars and inappropriate back to a sound base. Ensure joints and beds are free from dust and debris and dampened to control suction.
Mortar:	NHL 5 natural hydraulic lime and concrete sand with ligophob additive (water repellent)
Ratio:	1 part binder: 2.5 parts concrete sand (nominally by volume) and ligophob dosed at 100g per full bag of 25kg binder (check the bag is 25kg)
Mixing:	Combine binder and sand to achieve consistent colour in a paddle or forced action mixer, alternatively use a drill whisk mixer, add just enough water to achieve a plastic workable state for trowel application.
Application:	Apply in small volumes no thicker than 20mm with pieces of slate to ensure the voids are tightly packed. Leave surface flush with masonry and open textured. Timing of finishing joints is critical to avoid bringing fines to the surface.
Curing:	Cure with light misting with clean potable water such that the mortar does not fully dry out at any time within the first 4-5 days where ambient temperatures are 15^{0}C average and where protection is provided in circumstances where there is a risk of temperature fall. Should the average temperature drop by say 5^{0}C allow a further 3-4 days curing.

Mortar type C	For pointing rubble walls externally
Purpose:	To finish joints to plane, level and texture.
Masonry unit preparation:	Dampen individual units as required. Do not kill suction.
Mortar:	NHL 3.5 naturally hydraulic lime and local sharp Concrete Sand
Ratio:	(nominally by volume) 1 part binder to 2.5 parts sand
Mixing:	Add just enough water to achieve a stiff but workable consistency for bedding such that the mortar supports the masonry units without squeezing out unduly.
Application:	Where being used for finishing as building proceeds the excess mortar should be struck off the bed and cast or pointed back into a level plane of the face of the masonry units either by throwing and flattening off with a trowel or by placing with a trowel into hungry bed joints. Joints in masonry should not exceed more than 10mm without the use of pinning stones set in mortar as the build proceeds or well bedded where pinning for pointing work only. Use only pinning stones of a similar nature to the existing materials, (new replacement stone as stated may be cut, shaped or split from new blocks to provide suitable pinning stones).
Curing:	Cure with light misting with clean potable water such that the mortar does not fully dry at any time within the first three days, except where the walls may be damp, not wet, in which case the work should be covered only to avoid rapid drying on the face. Keep all work covered and ensure the top of the wall is under cover capable of protecting it from direct rainfall during the time when the site is unoccupied or when work is halted because of rain. Working in wet weather on an open wall head will not be permitted.

Scottish Lime Centre Trust
October 2017

Appendix B. Doocot Repair Schedule of Works (2016)

TRADITIONAL ROOFING & BUILDING LTD Consultant Contractor

ESTIMATE

Office/Yard Address:

4 Station Brae
Edinburgh
EH15 1LQ

0131 657 9994

enquiries@traditionalroofingandbuilding.co.uk
www.traditionalroofingandbuilding.co.uk

Or Find Us on

Reg in Scotland No:282126 . Vat No: 882 8436 82

Item	ESTIMATE 1 ROOFING WORKS	Quantity	Cost
	Slated Slopes		
1.01	Strip existing slates, timber sarking and joists and dispose of all debris from site.	Item	
1.02	Supply and fit new timber joists with required wall plate fitments includes securing new plywood sheet over new joists to accommodate slates.	Item	
1.03	Supply and fit one layer of breather felt to the timber sarking board; 150 laps fixed with galvanised clout nails.	Item	
1.04	Supply to site good quality 2nd hand scotch slate;include for dressing and sizing. (100% make up allowed)	25M2	
1.05	Re-slate roof laid to 75mm-50mm lap, head fixed with single galvanised nails and cheek nailed every third course allow for double eaves course and all straight and rake cutting.	25M2	
	Note: ***At the time of estimating this contract we were able to obtain 2nd hand Scottish slates.***		
	Cement Skews		
1.06	Hack out the existing skew detail and remove debris off site, install a felt soaker at each slate and reform skew in two coats of mortar as required.	15M	
	Pointing (Inside Faces Above Slated Slope Only)		
1.07	Raking out of all defective joints to a depth of not less than twice the width; rushing out; wetting; semi-recessed pointing with Broomhead sand & St Alistier NHL 3.5 (5:2) lime mix; rubbing down of joints with wetted sponge upon completion.	9M2	
	Scaffold Access		
	Erect, maintain, and later dismantle scaffolding to permit the safe execution of the above-mentioned works as per current Health & Safety Regulations.		
1.08	Full Front Elevation Scaffold.	Item	
1.09	Internal Scaffold.	Item	
	Total Amount		**£7,684.66 +20%VAT**

2.00	**ESTIMATE 2** **POINTING WORKS** Boundary Wall Pointing		
2.01	Raking out of all defective joints to a depth of not less than twice the width; rushing out; wetting; semi-recessed pointing with Broomhead sand & St Alistier NHL 3.5 (5:2) lime mix; rubbing down of joints with wetted sponge upon completion.	1M2	
	Total Amount		**£40.00** **+20%VAT**

Estimate Notes:
M = Meters
M2 = Meter Squared
Nr = Number
Item = No Quantity Needed

Appendix C. Sandstone Quarry Sources for Edinburgh's Buildings (British Geological Survey)

Quarry	Location	NGR	Stratigraphy	Status, Operator/Owners (correct as at 1999)
Auchinlea	Motherwell, Lanarkshire	NS 809 591	Middle Coal Measures	
Baberton	Edinburgh	NT 193 699	Craigleith Sandstone, Gullane Formation	
Ballochmyle	Mauchline, Ayrshire	NS 499 265	Mauchline Sandstone	
Barnton Park	Edinburgh	NT 197 759	? Craigleith Sandstone, Gullane Formation	
Bearford's Parks	Edinburgh	NT 255 740 approx.	Craigleith Sandstone, Gullane Formation	
Binny	Uphall, West Lothian	NT 057 730	Binny Sandstone, West Lothian Oil-Shale Formation	
Bishopbriggs (Huntershill and Kenmure)	Bishopbriggs	NS 608 695	Bishopbriggs Sandstone, Upper Limestone Formation	

Black Pasture	Hexham, Northumberland	NY 931 698	Millstone Grit	Active, Scottish Natural Stones Ltd.
Blair	Culross, Fife	NS 966 857	Passage Formation	
Blaxter	Elsdon, Otterburn, Northumberland	NY 931 873	Lower Limestone Group (England)	Active, Tynecastle Stone (Haydens Northern)
Braehead	Fauldhouse, West Lothian	NS 919 601	Lower Coal Measures	
Broughton	Edinburgh	NT 260 745 approx.	Craigleith Sandstone, Gullane Formation	
Burgh Muir (Meadows & Bruntsfield)	Edinburgh	NT 252 725	Kinnesswood Formation	
Carmyllie	Arbroath	NO 546 438	Dundee Formation	
Catcastle	Lartington, Barnard Castle	NZ 015 165	Millstone Grit	Active, Dunhouse Quarry Company Ltd.
Clashach	Hopeman, Moray	NJ 162 701	Sandstone of Hopeman	Active, Moray Stone Cutters
Closeburn	Thornhill, Dumfries & Galloway	NX 892 910	Thornhill Sandstone Formation	
Clunevar	Dunfermline, Fife	NT 070 890 approx.	Limestone Coal Formation	
Cocklaw	Chollerford, Northumberland	NY 938 703	Middle Limestone Group (England)	
Cockmuir	West Lothian	NT 067 765	Binny Sandstone, West Lothian Oil-Shale Formation	

Corncockle	Lochmaben, Dumfries & Galloway	NY 086 870	Corncockle Sandstone Formation	Active: Onyx Contractors
Corsehill	Annan, Dumfries & Galloway	NY 206 700	St Bees Sandstone Formation	Active: Onyx Contractors
Cragg	Bellingham, Cumbria	NY 820 850	Scremerston Coal Group(England)	C & M Stone Products Ltd.
Craigcrook (Well Craig, Old Kenny, Stevenson's)	Edinburgh	NT 213 742	Craigleith Sandstone, Gullane Formation	
Craigiemill	Edinburgh	NT 182 763	Hailes Sandstone, West Lothian Oil-Shale Formation	
Craigleith	Edinburgh	NT 226 745	Craigleith Sandstone, Gullane Formation	
Craigmillar	Edinburgh	NT 285 709	Kinnesswood Formation	
Craigton	West Lothian	NT 076 769	Binny Sandstone, West Lothian Oil-Shale Formation	
Cullalo (several quarries)	Aberdour, Fife	NT184 874	Grange or Cullalo Sandstone, West Lothian Oil-Shale Formation	
Cutties Hillock (Quarry Wood)	Elgin, Moray	NJ 185 635	Sandstone of Cutties Hillock	
Dalachy	Burntisland, Fife	NT 209 863	Grange Sandstone, West Lothian Oil-Shale Formation	
Dalmeny	West Lothian	NT 165 777	Binny Sandstone, West Lothian	

			Oil-Shale Formation	
Darney	West Woodburn, Northumberland	NY 910 870	Lower Limestone Group (England)	Active, Natural Stone Products
Denwick	Alnwick, Northumberland	NU 210 146	Middle Limestone Group (England)	
Doddington	Wooler, Northumberland	NU 008 326	Fell Sandstone Group	Active, Natural Stone Products
Dullatur	Kilsyth	NS 741 768	Bishopbriggs Sandstone, Upper Limestone Formation	
Dumbiedykes	Edinburgh	NT 265 732	Ballagan Formation	
Dunhouse (or Dunn House)	Staindrop, County Durham	NZ 114 195	Millstone Grit	Active, Dunhouse Quarry Company Ltd.
Dunmore (New)	Cowie, Stirling	NS 859 882	? Cowie Rock, Upper Limestone Formation	Active, Scottish Natural Stones Ltd.
Dunmore (Old)	Cowie, Stirling	NS 838 885	? Cowie Rock, Upper Limestone Formation	
Fairloans	Hawick	NY 595 968	Larriston Sandstone, Border Group	
Fordell (possibly Millstonemeadow)	Fife	NT 156 849	?Grange Sandstone, West Lothian Oil-Shale Formation	
Gatelawbridge(Newton Quarry)	Thornhill, Dumfries and Galloway	NX 902 965	Thornhill Sandstone Formation	Active, Scottish Natural Stones Ltd.
Giffnock, Braidbar Quarries	Glasgow	NS 568 593	Giffnock Sandstone, Upper	

			Limestone Formation	
Glanton Pike	Northumberland	NU 063 146	Fell Sandstone Group	
Grange	Burntisland, Fife	NT 223 867	Grange Sandstone, West Lothian Oil-Shale Formation	
Granton (Land and Sea Quarries)	Edinburgh	NT 221 772	Craigleith Sandstone, Gullane Formation	
Greenbrae	Hopeman, Moray	NJ 137 692	Sandstones of Hopeman	
Gunnerton	Gunnerton, Northumberland	NY 917 764	Middle Limestone Group (England)	
Hailes	Edinburgh	NT 208 706	Hales Sandstone, West Lothian Oil-Shale Formation	
Hawkhill Wood	Edinburgh	NT 291 711	Kinnesswood Formation	
Hermand	West Calder, West Lothian	NT 029 635	Binny Sandstone, West Lothian Oil-Shale Formation	
Heworthburn	Felling, Tyne and Wear	NZ 285 616	Middle Coal Measures	
Hopetoun White Quarry	Hopetoun Wood, West Lothian	NT 073 773	Binny Sandstone, West Lothian Oil-Shale Formation	
Humbie	West Lothian	NT 109 757	Binny Sandstone, West Lothian Oil-Shale Formation	

Humble, Aberdour	Aberdour, Fife	NT198 862	?Grange Sandstone, West Lothian Oil-Shale Formation	
Joppa	Edinburgh	NT 314 730	Upper Limestone Formation	
Lazonby: Stoneraise Quarry	Penrith, Cumbria	NY 533 358	Penrith Sandstone Formation	Active: Block Stone Ltd. (Realstone Ltd.)
Lazonby Fell Quarry	Penrith, Cumbria	NY 517 380	Penrith Sandstone Formation	Cumbria Stone Quarries Ltd.
Leoch	Tayside	NO 359 361	Dundee Formation	
Locharbriggs	Locharbriggs, Dumfries & Galloway	NX 990 810	Locharbriggs Sandstone Formation	Active, Baird & Stevenson (Quarrymasters) Ltd.
Longannet	Longannet, Fife	NS 950 857	Passage Formation	
Maidencraig (Blackball; Gibb's Quarry)	Edinburgh	NT 223 745	Craigleith Sandstone, Gullane Formation	
Milknock	Bellingham, Northumberland	NY 880 794	Scremerston Coal Group(England)	
Moat	Moat, Longtown	NY 398 738	St Bees Sandstone Formation	
Myreton	Dundee	NO 442 372	Dundee Formation	
Newbigging	Burntisland, Fife	NT 211 864	Grange Sandstone, West Lothian Oil-Shale Formation	Active, Scottish Natural Stones Ltd.
Niddrie	Edinburgh	NT 308 719	Limestone Coal Formation	

Pasturehill	Northumberland	NU 192 293	Lower Limestone Group(England)	
Plean (Blackcraig Quarry)	Stirling	NS 825 861	Bishopbriggs Sandstone, Upper Limestone Formation	
Polmaise	Stirling	NS 836 892	Cowie Rock, Upper Limestone Formation	
Prudham (& Purdovan)	Fourstones, Hexham, Northumberland	NY 886 689	Middle Limestone Group(England)	
Quarry Close	Edinburgh	NT 261 730	Gullane Formation	
Quarry Holes (Nether)	Leith	NT 270 753	?Ravelston Sandstone, Gullane Formation	
Quarry Holes(Upper)	Edinburgh	NT 275 753	Craigleith Sandstone, Gullane Formation	
Ravelston Black	Edinburgh	NT 212 736	Ravelston Sandstone, Gullane Formation	
Ravelston No.2 (Rosie's Quarry)	Edinburgh	NT 214 736	Ravelston Sandstone, Gullane Formation	
Ravelston Quarry(Old), north of Ravelston House	Edinburgh	NT 216 742	Craigleith Sandstone, Gullane Formation	
Redhall	Edinburgh	NT 215 701	Hailes Sandstone, West Lothian Oil-Shale Formation	

Salisbury: Camstone Quarry	Edinburgh	NT 271 734	Ballagan Formation	
Sands	Kincardine	NS 949 864	Passage Formation	
Society	Edinburgh	NT257 733	Ballagan Formation	
Spittal No.1	Watten, Caithness	ND172 540	Upper Caithness Flagstone Group	Active, A & D Sutherland
Spittal No.2	Watten, Caithness	ND166 545	Upper Caithness Flagstone Group	Active, Caithness Stone Industries Ltd.
Springwell	Gateshead, Tyne and Wear	NZ283 586	Middle Coal Measures	Active, Natural Stone Quarries Ltd.
Spynie	Elgin, Moray	N1222 657	Sandstone of Spynie	Active, Moray Stone Cutters
Stainton	County Durham	NZ070 189	Millstone Grit	Active, Natural Stone Products
Stancliffe	Darley Dale, Derbyshire	SK267 638	Millstone Grit	Stancliffe Stone Company Ltd.
Stanton Moor:	Stanton-in-Peak	SK249 642	Millstone Grit	Active, Realstone plc
Palmer's/Dale View	Stanton-in-Peak	SK249 645		Block Stone Ltd.
New Pillough Birchover	Birchover, Matlock	SK242 624		Natural Stone Products, Ennstone plc
Stoke Hall	Eyam, Derbyshire	SK237 770	Millstone Grit	Active, Stoke Hall Quarry Ltd.
Stonegunn	Castletown, Caithness	ND157 659	Upper Caithness Flagstone Group	Active, Caithness Stone Industries Ltd.
Straiton	Edinburgh	N1274 665	West Lothian Oil-Shale Formation	
Swinton	Greenlaw, Berwickshire	NT853 484	Cementstone Group	

Wattscliffe	Elton, Matlock	SK222 622	Millstone Grit	Active, Block Stone Ltd (Realstone Ltd.)
Wellfield (Crossland Hill)	Crossland Hill, Huddersfield, West Yorkshire	5E118 143	Rough Rock, Millstone Grit	Active, Johnsons Wellfield Quarries Ltd.
Whitsome Newton	Greenlaw, Berwickshire	NT854 486	Cementstone Group	
Woodburn (also Parkhead)	West Woodburn, Northumberland	NY902 858	Lower Limestone Group(England)	
Woodkirk	Morley, Yorkshire	SE268 263	Middle Coal Measures	Active, Pawson Brothers Ltd

Appendix D. Photo Schedule

Granton Waterfront Materials Assessment - Photographic Schedule

Ref	Photographic Record	Location	Note
1.1		Former Customs House	
1.2		East Elevation of Former Customs House	
1.3		Rear Elevation of Former Customs House	

1.4		West brick extensions to 1 West Harbour Road, Former Bonded Warehouse	
1.5		1 West Harbour Road, Former Bonded Warehouse	
1.6		1-4 Granton Square	

1.7		8 Granton Square, Former Granton Hotel	
1.8		160 Lower Granton Road	
1.9		158A Lower Granton Road	

1.10		Former Goods Shed	
1.11		Building of unknown history on West Harbour Road	
1.12		Brick outbuildings to rear of Former Bonded Warehouse	

1.13		Granton Castle Walled Garden	Remnants of arched opening where walled garden adjoined the castle.
1.14		Etna brick found in Granton Castle Walled Garden	

1.15		Recently repaired north wall to Granton Castle Walled Garden	
1.16		Niddrie bricks to former greenhouse wall	
1.17		Dougal Winchburgh Bricks to wall in Walled Garden	

1.18		Special ’12’ and ‘10’ bricks	
1.19		Walls constructed from Dougal Winchburgh bricks	

1.20		Smeaton brick reused in walled garden	
1.21		Central rubble wall topped with red bricks running east – west in Walled Garden	
1.22		Outbuilding adjacent to Caroline Park House with Granton Bricks	

1.23		Granton Bricks in Outbuilding	
1.24		Doocot	
1.25		South wall of Walled Garden	

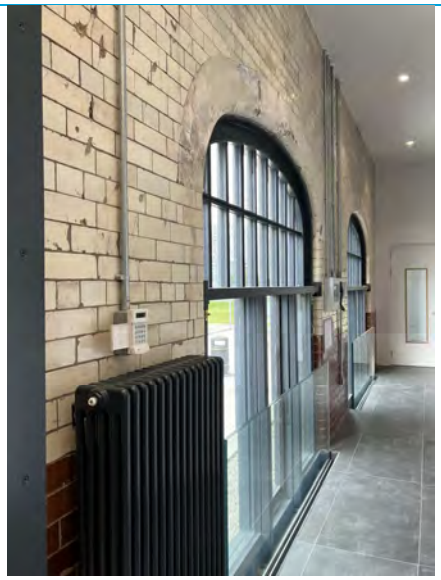
1.26		Granton Lighthouse from West Harbour Road	
1.27		Chamfered alteration	
1.28		East Elevation of Lighthouse	

1.29		East Elevation of Lighthouse	
1.30		Dennis Ruabon	
1.31		Brickwork to West Elevation – note the circular marks to the bricks	

1.32		Note the change in bricks to the	
1.33		Whitehill Bricks to outbuilding	Note deterioration of bricks due to cementitious mortar.
1.34		Cementitious pointing to outbuilding	

1.35		View north with garden wall	
1.36		West elevation of outbuilding	
1.37		Garden wall – Niddrie Bricks visible.	

1.38		Granton Station	
1.39		Granton Station Platform	
1.40		Low boundary wall	

1.41		Main Façade to Granton Station	
1.42		Interior of Station	Note glazed bricks
1.43		Madelvic House Main Facade	

1.44		Red sandstone architrave and red bricks to main façade	
1.45		Replaced plinth to main façade	
1.46		Coltness Brick found in garden of Madelvic House	

Appendix E. Maintenance

E.1 Planned Maintenance Schedule

We would recommend preparing a 10 year Planned Maintenance Schedule for each of the key buildings discussed in the report above. This should include routine repairs, such as:

- Clear rhones and downpipes of debris and assess for any cracks or loose joints at least six monthly or ahead of any expected high rainfall;
- Clear valley and parapet gutters and check lead lining for any splits;
- Remove any debris or plant growth;
- Check for slipped slates;
- Check below ground drainage;
- Re-paint external paintwork approximately every 5 years;
- Check putty to glazing;
- Assess the condition of masonry, especially at high level; and
- Make sure that garden or landscaping materials are not accumulating against walls.

The above list is not exhaustive and schedule should be created to be specific to the site.

A record of materials used for repairs should be kept, including items such as:

- Lime mortar mix;
- Slates used;
- Stone or bricks used; and
- Paint – manufacturer, colour and finish.

Again, the above list is not exhaustive but provides an example of the materials which should be recorded to make future repairs easier and to ensure the same materials are being used.

Appendix F. BGS Sample

GeoReports

British Geological Survey

Antonio Cabello
AtkinsRéalis
10 Canning Street
Edinburgh
EH3 8EG

Building Stone Assessment:

The BGS Building Stone Assessment service combines geological expertise and building conservation expertise to provide authoritative advice to clients wishing to specify natural stone for repairing or building stone structures. Samples of stone supplied by clients are compared with samples from active quarries held in the BGS Collection of UK Building Stones to identify the closest-matching currently available stone(s). Using the closest-matching stone type in repairs to stone structures maximises the likelihood that the replacement stone will co-exist harmoniously with the 'original' stone and will weather sympathetically.

Report Id: GR_335593
Site Address: Granton Castle Walled Garden, West Shore Road, Edinburgh EH5 1QB.
Date sample received: 17/10/2023
Sample Number: ED12408
Date of Report: 04/12/2023

Building Stone Assessment

Granton Castle Walled Garden, Edinburgh

1. Introduction

BGS has been asked by Antonio Cabello, acting on behalf of AtkinsRéalis, to perform a Building Stone Assessment on a sample of masonry from Granton Castle Walled Garden in Edinburgh. The stone walling at this site is to undergo repair and partial reconstruction.

The purpose of a Building Stone Assessment is to identify which stones from the range currently being supplied by quarries in the UK most closely match the stone requiring repair or replacement. Background information relating to a BGS Building Stone Assessment of sandstone is presented in Appendix 1.

The client has provided a sample of the existing masonry for analysis, which is assumed to be representative of the 'original' stone requiring replacement. The sample comprises a single piece of brownish grey sandstone measuring approximately 55 x 45 x 40 mm; this was assigned the BGS sample number ED12408 (see Figure 1).

A thin section was prepared from the sample to enable petrographic analysis of the stone. The client has indicated that various repairs are planned to rubblestone masonry comprising blocks of the type represented by the supplied sample.

A BGS Building Stone Assessment is usually performed in three stages.

(i) The sample of 'original' stone (usually supplied by the client) is first subjected to a detailed petrographic examination, to establish the range and character of its intrinsic properties.

(ii) The range of properties is then compared with those of stone samples held in the BGS Collection of UK Building Stones, to constrain the source of the stone. Historical records (if available), and the likelihood that the stone was sourced locally or imported, are also taken into account.

(iii) Finally, the closest-matching currently available stones are identified. If the quarry from which the stone was sourced originally has been identified, and is still open, it will usually provide the closest-matching stone. If the quarry from which the stone was sourced originally has not been identified, or is closed, the closest-matching currently available stones are identified by comparing the properties of the 'original' stone with those of samples of currently available stones held in the BGS Collection of UK Building Stones.

Comparing stone properties to identify the source and/or the closest-matching stones is known as stone matching. Further details of the methodology applied to stone matching are provided in Appendix 2.

Figure 1. Image of sample ED12408. The supplied sample piece was sawn in two as part of the thin sectioning process. Ruler (with main divisions in cm) for scale.

2. Petrographic description of sample ED12408

See Appendix 3 for notes describing each numbered item below.

Hand specimen observations

Stone type [1] (general classification): sandstone
Stone colour [2] **–** fresh stone: brownish grey
Stone colour [2] **–** weathered stone: grey
Stone cohesion [3] – fresh stone: strongly cohesive
Stone cohesion [3] – weathered stone: strongly cohesive
Stone fabric [4]: faintly laminated (parallel lamination)
Distinctive features: none

Thin section observations

Stone constituents [5]:

Granular (detrital) constituents		*Intergranular constituents*	
Quartz	77%	Silica (overgrowth)	4%
Feldspar	0%	Feldspar (overgrowth)	0%
Rock fragments	1%	Carbonate	0%
Mica	0%	Iron/manganese oxide	<1%
Opaque material	<<1%	Clay	<<1%
Other	<<1%	Hydrocarbon	0%
Intragranular pores	2%	Intergranular pores	16%

Stone type [1] (detailed classification): quartz-arenite
Grain-size [6]: fine-sand-grade to medium-sand-grade
Grain sorting [7]: well-sorted
Grain roundness [8]: sub-angular to sub-rounded
Stone permeability [9]: high
Cement distribution [10]: silica cement continuous
Supergene changes [11]: none

Comments

None.

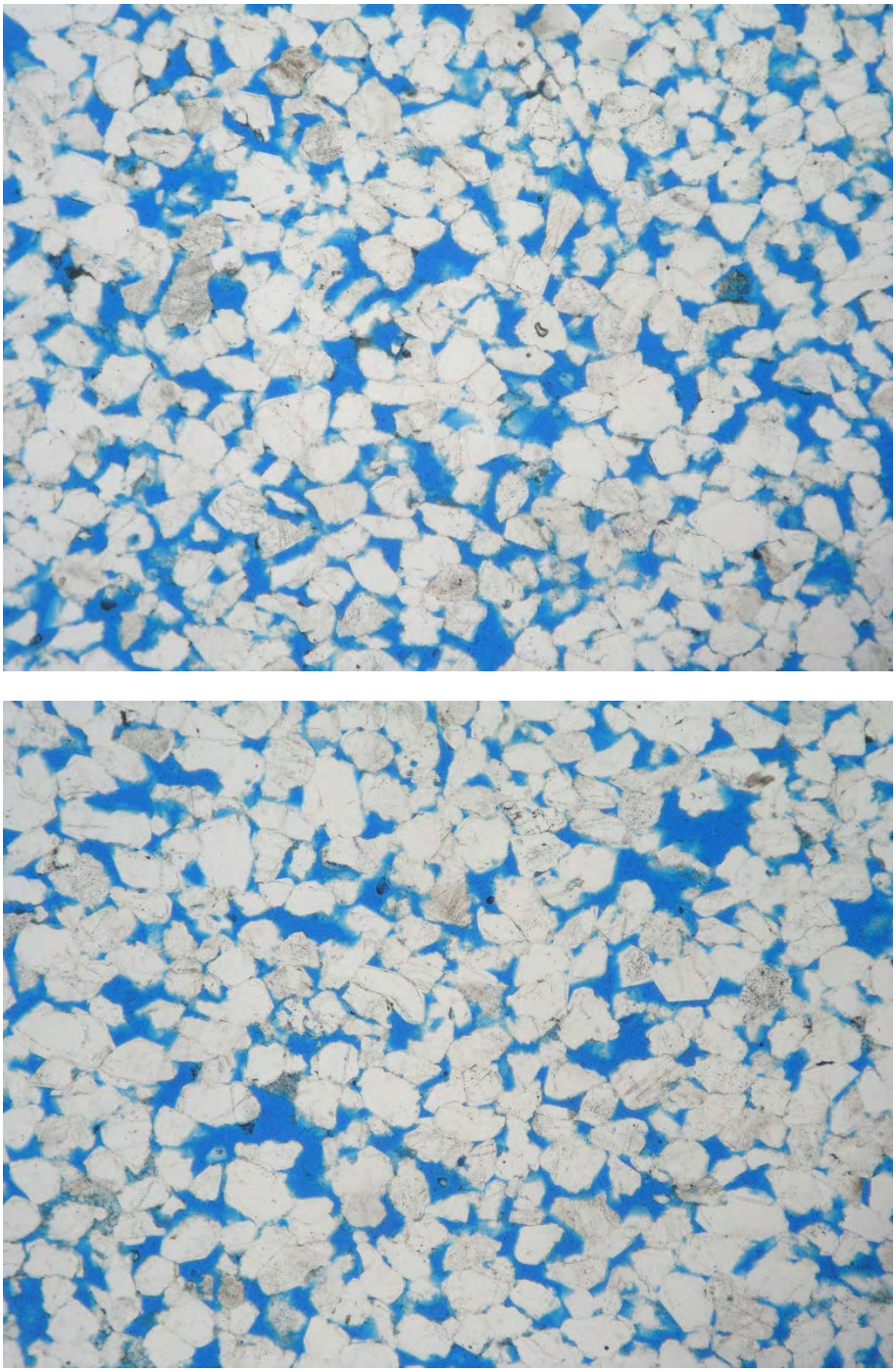


Figure 2. Thin section photographs of sample ED12408. Grains of quartz appear white. Iron oxide particles (tiny in this case) appear black, and pore space appears blue. The images were taken in plane-polarised light, and the field of view is *c.* 3.3 mm wide.

3. Source of the stone

Our assessment of the source of the 'original' stone (as represented by the supplied sample), in terms of bedrock geology, bedrock age and quarry, is summarised below. The letters D (definite), L (likely), P (possible) and NK (not known) indicate the level of confidence attached to the assessment. Identification of the bedrock unit is based on the similarity of the supplied stone sample to sample(s) of that unit held in the BGS Collection of UK Building Stones.

Bedrock unit:	Gullane Formation	L
Age:	Carboniferous (359–299 million years ago)	L
Quarry area:	Granton (Edinburgh)	L
Quarry name:	Granton / other	P
Quarry status:	closed	

Comments

The mineralogical and textural characteristics of sample ED12408 broadly resemble those of BGS-held samples originating from certain quarries that formerly extracted sandstone from the Gullane Formation. Strata assigned to the Gullane Formation underlie the Granton Castle Walled Garden site, and we note that the local bedrock was formerly extensively quarried for building stone at the Granton quarries, some 500 m to the west. Another un-named quarry also once existed *c.* 100 m to the east of the walled garden[1]. Both this un-named quarry and the Granton quarries are identified as possible sources of the stone used for the walling that encloses Granton Castle Walled Garden.

All of the quarries in the Edinburgh area, as well as those in other parts of Scotland, which formerly extracted sandstone from the Gullane Formation are now closed. Most of the sites in question have been infilled and are no longer accessible.

[1] Ordnance Survey 25 inch to the mile map series, 1892–1914. Available via the National Library of Scotland Map images portal: https://maps.nls.uk/geo/explore/#zoom=17.1&lat=55.98249&lon=-3.24234&layers=168&b=1

4. Closest-matching currently available stones

None of the quarries that potentially produced the sandstone represented by the supplied sample is active today, so an assessment of the closest-matching currently available stones has been made. The selection of closest-matching stones provided in this section of the report has been arrived at by comparing the intrinsic properties of the supplied stone sample with those of samples of currently available stones held in the BGS Collection of UK Building Stones.

Brief, relevant details for each stone are provided to enable a simple evaluation of how their appearance and character compares with the sample of stone from the building.

Unless stated otherwise, the grain-scale intrinsic properties (grain-size, mineral composition, texture etc.) of the closest-matching stones listed below are broadly similar to those of the 'original' stone. All of the photographs in this section were taken in plane-polarised light, and the field of view is *c.* 3.3 mm wide. Pore space appears blue.

Please keep in mind the following points when considering the list of closest-matching stones.

- The list of closest-matching stones has been arrived at by comparing the stone to be repaired with samples of stone obtained from currently active quarries. The characteristics of stone from a quarry source can vary over time and from place to place within the quarry; there is therefore no guarantee that a sample of quarry stone held by BGS is representative of the stone currently being supplied by the quarry.
- One or more samples of stone should be obtained from a quarry operator prior to stone specification, to confirm the appearance and character of the stone currently being supplied.
- The mention of specific stone types should not be taken as an endorsement, or otherwise, of the quality of a particular product.
- Specific functional requirements, block dimension requirements, and the ability of a stone to give a particular masonry tooled finish should be discussed with the supplier prior to specification.
- The inclusion of any stone within the list of 'closest-matching stones' does not guarantee that it will weather sympathetically or co-exist harmoniously with the 'original' stone. The BGS Building Stone Assessment is designed to **maximise the likelihood** that a replacement stone and the original stone will be compatible. However, the small number and range of currently available stones compared to those that have been used in the past mean that it is commonly not possible to identify an ideal match. Furthermore, several factors – including the highly variable character of natural stone, the wide range of natural and human factors that can influence stone decay, and the wide range of environmental settings and conditions that masonry can be subjected to – mean that it is not possible to predict with certainty how replacement stone will perform in masonry.

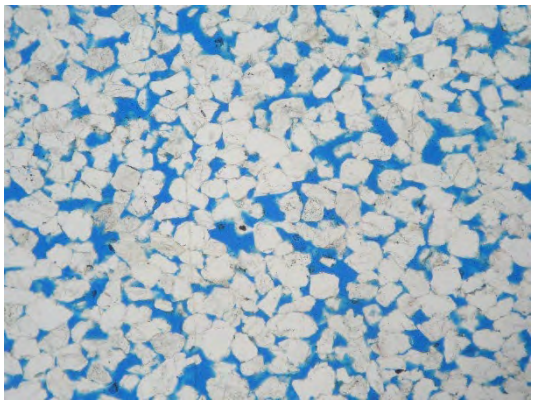
Please also note:

- Where a substitute stone is placed next to ‘original’ stone in stonework (particularly in ashlar) the two stones ideally should have similar permeability characteristics; if they do not, moisture and air might be prevented from moving freely through the stonework which over time can lead to localised stone decay.
- Mortar can also play an important role in inhibiting the free movement of moisture and air through stonework. It will be important therefore to use a permeable mortar (e.g. lime mortar, which ideally should be at least as permeable as the ‘original’ stone), as well as a compatible replacement stone, in any repair, to increase the chance of producing a long-lasting, successful outcome. Portland cement, which is essentially impermeable, should not be used as mortar in stonework.

‘Original’ stone: Granton Castle Walled Garden, Edinburgh

The characteristics recorded here are based on the sample supplied by the client.

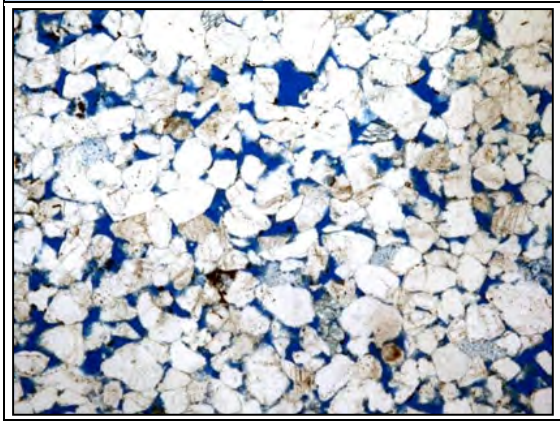
Colour (fresh stone): brownish grey
Stone fabric: faintly laminated (parallel lamination)
Grain-size: fine-sand-grade to medium-sand-grade
Distinctive features: none
Cohesion (freshest stone): strongly cohesive
Permeability: high



Closest-matching stones

The descriptions that follow refer to the typical character of the stone supplied by each quarry, as represented by samples held in the BGS Collection of UK Building Stones, but will not encompass all of the variation that may be encountered. We recommend that samples representing the full current production range of each quarry are obtained for an on-site visual comparison with the existing stonework, in order to assess which variant provides the best match in terms of appearance.

Hazeldean sandstone	
Colour:	White to light grey, with buff and pink tones.
Stone fabric:	Uniform (with some aligned grains indicating the bedding orientation).
Grain-size:	Fine-sand-grade to medium-sand-grade.
Permeability:	High.
Distinctive features:	None.
Comments:	Hazeldean sandstone can range in colour from white to light grey with buff and pink tones. Samples representing the current production range in full should be obtained from the supplier in order to assess which provides the closest match for the existing masonry in terms of appearance. If light grey Hazeldean sandstone can be obtained, this should provide a reasonably close match for the stone featuring in the walls of Granton Castle Walled Garden (as represented by sample ED12408), in terms of both petrographic and macroscopic characteristics.



Supplier details:

Hutton Stone Co Ltd.
Masons & Stone Merchants
West Fishwick
Berwick-upon-Tweed
TD15 1XQ

Tel: 01289 386056

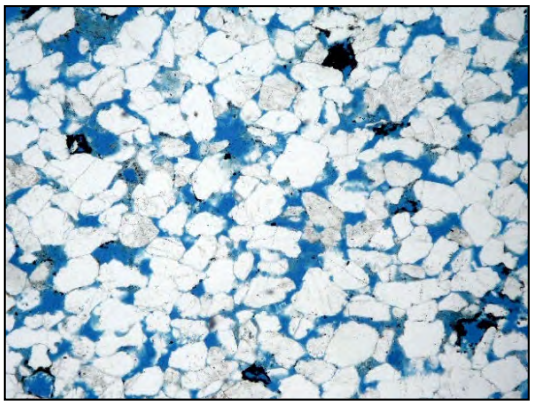
Email: info@huttonstone.co.uk

Web page: https://www.huttonstone.co.uk/

(list of closest-matching stones continues on page 10)

Camphill sandstone (a.k.a. Gunnerton Sandstone)

Colour:	Light buff.
Stone fabric:	Can be uniform or faintly bedded.
Grain-size:	Medium-sand-grade.
Permeability:	High.
Distinctive features:	None.
Comments:	Camphill sandstone is also sometimes known as ‘Gunnerton sandstone’.



Supplier details:

Robert Charlton
Border Stone Quarries
Haltwhistle
Northumberland
NE49 0HQ

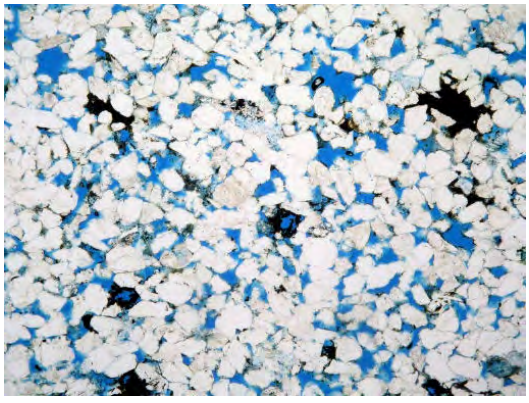
Tel: 01434 322140

Email: enquiries@borderstonequarries.com

Web page: https://borderstonequarries.com

Darney sandstone

Colour:	Very light buff to buff with occasional orangish banding. One bed in the quarry is almost white.
Stone fabric:	Mostly uniform, occasionally with faint parallel bedding. The bedding orientation is indicated by aligned mica flakes.
Grain-size:	Fine-sand-grade to medium-sand-grade.
Permeability:	High.
Distinctive features:	The stone can contain iron oxide banding, though this is unlikely to affect its performance significantly.
Comments:	None.



Supplier details:

Hutton Stone Co Ltd.
Masons & Stone Merchants
West Fishwick
Berwick-upon-Tweed
TD15 1XQ

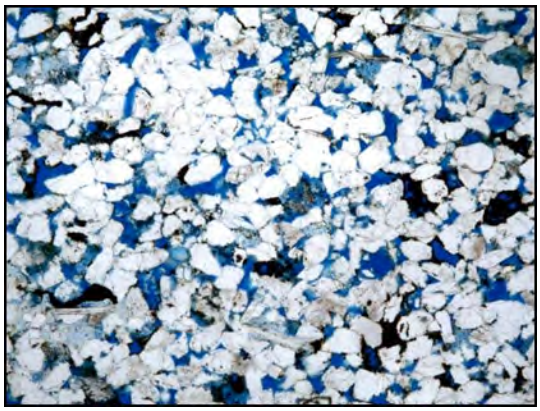
Tel: 01289 386056

Email: info@huttonstone.co.uk

Web page: https://www.huttonstone.co.uk/

(list of closest-matching stones continues on page 11)

Dunhouse Buff sandstone	
Colour:	Light buff to buff.
Stone fabric:	Uniform (with some aligned grains indicating the bedding orientation).
Grain-size:	Fine-sand-grade to medium-sand-grade.
Permeability:	High.
Distinctive features:	The stone can contain scattered black carbonaceous flakes typically up to 10 mm long.
Comments:	None.



Supplier details:

Dunhouse Natural Stone
Dunhouse Quarry Ltd.
Darlington
County Durham
DL2 3QU

Tel: 01833 660208

Email: enquiries@dunhouse.co.uk

Web page: https://dunhouse.co.uk

(end of list of closest-matching stones)

Analysis by: **Luis Albornoz & Paul Everett**

Checked by: **Dr Stephen F. Parry**

Date: 04/12/2023

British Geological Survey

The Lyell Centre, Research Avenue South, Edinburgh EH14 4AP

Background to a BGS Building Stone Assessment of sandstone

Sandstone consists of adhering sand grains with unfilled gaps (pore spaces) and/or a mineral ‘cement’ between the grains. Sand grains are small – between 2 and 0.064 millimetres in diameter – so many of the intrinsic properties of a sandstone, including the relative proportions of the various constituent minerals, the grain-size and textural arrangement of the constituents, and the porosity (pore space) characteristics, can only be determined accurately by microscope examination. Some properties, including the colour and fabric of the stone, can be determined adequately with the unaided eye. Still others, including the cohesiveness and permeability of the stone, require a simple test to make an adequate evaluation. Each property can vary considerably from one sandstone to another, and no two sandstones are identical.

Each of the intrinsic properties of sandstone plays a role in determining how any one stone responds to the complex physical and chemical processes associated with weathering. The result is that no two sandstones respond to weathering in exactly the same way and at the same rate. If more than one type of sandstone is used in a stone structure, obvious contrasts in the appearance and condition of masonry blocks commonly become apparent over time. Furthermore, placing two sandstones of contrasting permeability next to each other in masonry can lead one (usually the more permeable stone) to suffer accelerated decay. For these reasons, it is generally considered good practice to repair or replace ‘original’ sandstone masonry with sandstone that is the closest achievable match in terms of the properties that govern how the stone responds to weathering (‘weathering properties’). This maximises the likelihood that the replacement stone will co-exist harmoniously with the ‘original’ stone and will weather sympathetically. The poorer the match between the weathering properties of the replacement stone and the ‘original’ stone, the greater is the likelihood that the condition and appearance of the two stones will diverge over time.

The purpose of a Building Stone Assessment is to identify which stones from the range currently being supplied by quarries in the UK most closely match the stone requiring repair or replacement. Special requirements of the replacement stone – for example, load-bearing capacity, suitability for carving or tooling, and salt resistance – are taken into consideration if requested.

Appendix 1. Methodology

A BGS Building Stone Assessment is usually performed in three stages.

(i) The sample of 'original' stone (usually supplied by the client) is first subjected to a detailed petrographic examination, to establish the range and character of its intrinsic properties.

(ii) The range of properties is then compared with those of stone samples held in the BGS Collection of UK Building Stones, to constrain the source of the stone. Historical records (if available), and the likelihood that the stone was sourced locally or imported, are also taken into account.

(iii) Finally, the closest-matching currently available stones are identified. If the quarry from which the stone was sourced originally has been identified and is still open, it will usually provide the closest-matching stone. If the quarry from which the stone was sourced originally has not been identified, or is closed, the closest-matching currently available stones are identified by comparing the properties of the 'original' stone with those of samples of currently available stones held in the BGS Collection of UK Building Stones.

Comparing stone properties to identify the source and/or the closest-matching stones is known as stone matching.

Petrographic examination

A macroscopic examination of the sample of 'original' stone is performed with the unaided eye and using a binocular microscope. A microscope examination is performed on a thin section (a slice of the stone sample cut thin enough to be transparent), using a polarizing microscope. Before preparing the thin section, the stone is impregnated with blue resin to highlight pore spaces. The thin section is cut perpendicular to the bedding fabric of the stone (where this is visible), and is positioned to be as representative as possible of the sample. The thin section is typically cut to include the freshest part of the supplied stone sample, and also any weathered part and/or exposed (exterior) surface where these are present.

Observations from these examinations are recorded on a Petrographic Description Form designed for building stones, to ensure the description is systematic and consistent with the procedures set out in British Standard BS EN 12407:2000 (*Natural stone test methods – Petrographic examination*). The completed Petrographic Description Form is included in this report, with a set of accompanying notes describing each of the recorded properties. The description is accompanied by one or more photographs illustrating the typical character of the stone as it appears in the thin section.

Stone matching

Where possible, the source (quarry and bedrock unit) of the 'original' stone is determined by comparing it with samples held in the BGS Collection of UK Building Stones; historical records (if available), and the likelihood that the stone was sourced locally or imported, are also taken into account, if appropriate. Many thousands of quarries in the UK have supplied building stone in the past, and in many instances it is not possible to relate a stone sample back to one particular quarry or bedrock unit.

Where the source cannot be identified unambiguously, the closest-matching currently available stones are identified by comparing the intrinsic properties of the ‘original’ stone with those of similar stones that are currently being supplied by quarries in the UK.

The following factors are taken into account when comparing an ‘original’ stone with a potential replacement stone.

1) *Mineral and textural features* – ideally, these should be as similar as possible in the replacement stone and ‘original’ stone, to increase the likelihood that the two stones will respond in similar ways and at similar rates to the various physical and chemical processes associated with weathering, and will therefore co-exist harmoniously. Replacement stones are selected to match the ‘original’ stone in its fresh (rather than weathered/decayed) state, unless otherwise requested. Particular attention is paid to those minerals and textural features that are known to play a significant role in sandstone decay and discolouration.

2) *Permeability* – ideally, the replacement stone and ‘original’ stone should have similar permeability characteristics, thereby minimising the degree to which fluid (water and air) migration between adjacent blocks of ‘original’ and replacement stone might be impeded. Accelerated stone decay can occur where fluid migration is impeded.

3) *Appearance* – for aesthetic reasons, the replacement stone and ‘original’ stone ideally should look similar to the unaided eye in terms of colour and stone fabric at the time the repair is made. However, the closest-matching stones in terms of the properties that govern weathering performance (mineral-textural features and permeability) are not necessarily the closest match in terms of appearance. A repair using stone selected primarily because it is the closest match in terms of appearance may look good initially but could quickly show signs of decay or of being incompatible with the ‘original’ stone. For that reason, priority is generally given to the properties that govern weathering performance, thereby maximising the likelihood of long-term compatibility of the ‘original’ stone and replacement stone. A degree of compromise may in some cases be desirable and acceptable if the closest-matching stones in terms of ‘weathering properties’ are not a close match in terms of appearance. Immediately following repair, the fresh surfaces of a stone insert or indent will usually contrast in appearance with the soiled or discoloured surfaces of adjacent ‘original’ masonry, but if the ‘weathering properties’ of the two stones are a good match the new stone should blend in over time and the contrast should become less obvious.

4) *Functional and performance requirements* – specific functional and performance requirements of a replacement stone are taken into account if requested. For example, if the ‘original’ stone performed a load-bearing role, the choice of matching stones should include only those that are at least as strong; and if the ‘original’ stone was carved or shaped in a particular way, the choice of matching stones ideally should include only those that can be carved or shaped in a similar way, with a similar level of detail and quality of finish.

One or more replacement stone types are proposed taking these factors into account. A brief description and a thin section photograph are provided for each.

Appendix 2. Supporting notes for the petrographic description

Each numbered note below relates to a superscript number in the Petrographic Description Form (Section 2).

1 The determination of stone type follows the classification and nomenclature of the BGS Rock Classification Scheme.

2 The determination of stone colour is based on a simple assessment with the unaided eye in natural light. In stones displaying variable colour, the determination records the colour deemed by the geologist to be most representative. The determination of stone colour is made on a broken (not sawn), dry surface.

3 A simple, non-quantitative assessment of the degree to which the stone is cohesive. This property is recorded in terms of four conditions, each representing one segment of a continuum: *strongly cohesive*, *moderately cohesive*, *moderately friable*, and *very friable*. The grains in a *strongly cohesive* stone cannot be disaggregated by hand, whereas the grains in a *very friable* stone can be readily disaggregated by hand.

4 A record of whether the distribution of granular (detrital) constituents in the sample is essentially isotropic (uniform) or anisotropic (non-uniform). The type of anisotropic fabric is recorded.

5 A record of the identity and relative proportions of all granular (detrital) and intergranular (authigenic materials and pore space) constituents currently in the stone. The proportions are estimates, expressed in %, which are based on a visual assessment of the whole thin section area.

6 The terms are those used for grain-size divisions in the BGS Rock Classification Scheme.

7 A simple, non-quantitative assessment of the degree to which detrital constituents display similarity in terms of physical characteristics (in particular the size and shape of grains).

8 A simple, non-quantitative assessment of the degree to which detrital constituents are abraded.

9 A simple, non-quantitative assessment of stone permeability, presented as one of five conditions (*very low*, *low*, *moderate*, *high*, *very high*) expressed relative to a nominal ‘average’ permeability in building stone sandstones. The assessment is based on: (i) a water bead test; (ii) the proportion of pore space in the stone; (iii) a visual assessment of the degree to which pore spaces appear connected in the thin section.

10 A record of the type and extent of authigenic mineral cement that acts to bind detrital grains, as observed in thin section. *Isolated* means the cement occurs in discrete locations (e.g. as overgrowths on individual detrital grains) that are typically not connected in the plane of the thin section. *Discontinuous* means the cement is formed in patches, each of which typically encloses several to many detrital grains. *Continuous* means the cement is more-or-less connected across the thin section.

11 A record of the evidence observed in thin section for mineral alteration that occurs in the stone when it is near the ground surface. Such alteration processes typically begin before stone is quarried, but some may continue, or be initiated, after stone is extracted from the ground.

Contact Details

Keyworth Office
British Geological Survey
Environmental Science Centre
Nicker Hill
Keyworth
Nottingham
NG12 5GG
Tel: 0115 9363143
Email: enquiries@bgs.ac.uk

Edinburgh Office
British Geological Survey
Lyell Centre
Research Avenue South
Edinburgh
EH14 4AP
Tel: 0131 6671000
Email: enquiry@bgs.ac.uk

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- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

Report issued by
BGS Enquiry Service

AtkinsRéalis

Fiona Arnot
AtkinsRéalis
2 Atlantic Square,
Glasgow

Fiona.Arnot@atkinsrealis.com

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