SAFEGUARDING GLASGOW'S STONE BUILT HERITAGE
SKILLS AND MATERIALS REQUIREMENTS:

FAÇADE SURVEYS AND BUILDING STONE ANALYSIS

A REPORT COMMISSIONED BY THE SCOTTISH STONE LIAISON GROUP
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Safeguarding Glasgow's Stone Built Heritage Skills and Materials Requirements: Façade Surveys and Building Stone Analysis

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Glasgow, building stone, stone decay, sandstone.

Front cover

Example of surveyed facade; rectified image with digital overlays showing areas of stone decay.

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Preface

This report presents the results of a study commissioned by the Scottish Stone Liaison Group on behalf of Scottish Enterprise Glasgow (SEG). The work was undertaken in order to provide data on the quantities of replacement building stone and the amount of time and skills levels required for stone masons, for the repair and maintenance of the stone built heritage of the City of Glasgow over the next twenty years (2006 to 2026). The study was undertaken by the British Geological Survey, overseen by an external project director and guided by a project Steering Group appointed by the Scottish Stone Liaison Group. This study is Project B: 'Buildings Health Check', forming part of the project 'Safeguarding Glasgow's Stone Built Heritage: Skills and Materials Requirements'. The project is funded by Scottish Enterprise Glasgow, with contributions by Glasgow City Council,

The work has involved the survey of the facades of over 230 traditional stone buildings and monuments in Glasgow in order to assess the amount, type and severity of stone decay. In order to do this, a methodology was developed which involved the use of rectified digital images overlaid with measured areas of different stone decay categories. Calculation of stone quantities and stonemason requirements was undertaken by an external consultant appointed by the Steering Group. A range of buildings of different type, facade orientation, stone type and from different parts of the city were included in order to ensure that the sample of surveyed buildings is representative of Glasgow's stone heritage.

A further objective of the work was the analysis of samples of stone from over 100 of the surveyed buildings, in order to establish the variety and to identify the principal types of building stone used in the city. All of the samples analysed are sandstone, mainly local pale Carboniferous 'blonde' sandstone used from the earliest periods of the city's development, and 'red' sandstone mostly transported from other parts of Scotland and used from the late 19th century onwards. Petrographic analysis of the samples has identified six main categories of blonde sandstone and four categories of red sandstone. Whilst some of the original red sandstone quarries are still active, all of the blonde sandstone quarries in the Glasgow area have ceased production, which has implications for the supply of appropriate stone for repair and maintenance.

The results of the stone quantities and mason's time and skill level calculations for the surveyed facades have been extrapolated to provide an estimate of the total stone and masonry requirements for the entire city. In order to do this a stone buildings count was undertaken using a combination of current and historical map interpretation and field surveys to obtain an accurate number for the entire population of traditional stone buildings within the city of Glasgow.

The data presented in this report will be used in the preparation of a report by the Scottish Stone Liaison Group for Scottish Enterprise Glasgow, providing a prediction of the craft skills and materials required to ensure the future viability of Glasgow's stone heritage, and forms a part of the SEG Construction Skills Action Plan for Glasgow. The surveys undertaken in this study are intended solely to provide information relating to the condition and type of stone on specific facades. They do not constitute a building survey undertaken by a surveyor, and are not related to the overall condition or value of properties.

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1. INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The Scottish Stone Liaison Group (SSLG) was commissioned by Scottish Enterprise Glasgow (SEG) in late 2004 to undertake an investigation to determine the stone masonry skills needs required to conserve the stone-built heritage of Glasgow over the next twenty years. The project 'Safeguarding Glasgow's Stone Built Heritage: Skills and Materials Requirements' is the direct result of this commission. The aim of the project is 'to investigate the condition of Glasgow's stone heritage to enable an accurate prediction to be made of the craft skills and materials that will be required to ensure the future viability of this heritage'. The project forms part of the SEG Construction Skills Action Plan for Glasgow, with the aim of supporting the development of the Glasgow construction workforce.

The SSLG project involves two separate research elements, namely a Workforce Skills Needs (Project A), and Buildings 'Health Check' (Project B). The British Geological Survey (BGS) was appointed in December 2004 to undertake Project B, and the results of this study are presented in this report.

1.2 BACKGROUND TO THE PROJECT

There is concern about the availability of stonemasonry skills and training in Scotland, and the potential impact that a shortage of these skills could have on the stone-built heritage of Scotland, and Glasgow in particular. It has become clear that the stone heritage of Glasgow (and elsewhere in Scotland) is at considerable risk from a number of factors which are influencing stone decay. Sandstone is the dominant building stone type used in Glasgow. Many of city's stone buildings were built in the second part of the 19th century and are now of an age where some of the stonework is showing signs of decay and require repair. The legacy of air pollution from industry and domestic coal burning through much of the 20th century has accelerated stone decay in many parts of the city. Secondly, inappropriate repairs have further exacerbated the problem, in particular the proliferation of so-called 'plastic' repairs using impervious cement materials applied to softer, porous sandstone. The extensive use of these repair methods in the second half of the 20th century has created a situation where many stone buildings in the city are in need of imminent stone replacement.

Research sponsored by Historic Scotland in the last decade or so has shown that other factors have also contributed to the damage to historic stonework. Uncontrolled stone cleaning, much of which took place during urban regeneration in the late 20th century, has resulted in a significant deterioration of the sandstone on both listed and non-listed buildings (Webster 1992). In addition, recent research has shown that repairs using incompatible stone types and mortars can result in accelerated decay of the remaining original stone masonry (Hyslop 2004). Finally, at a time when climate change predictions indicate that increasing rainfall is likely to occur through this century, it is imperative that buildings are correctly repaired and maintained, given that water is widely recognised as the main agent of building stone decay in Scotland.

There are many reasons why this situation has developed (see Hutton & Rostron 1997 for a full discussion). The rise of man-made construction materials and the changing economies between and after the two World Wars led to a collapse in the Scottish building stone industry. In the late 19th and early 20th century there were several hundred commercial sandstone quarries operating in the Scottish central belt, whilst today only one quarry is in production. For example, a recent study in Edinburgh has estimated that over 90% of the sandstone used for recent repairs comes from quarries in the north of England (Hyslop 2004). Secondly, the changing nature of the construction industry has led to a loss of knowledge and lack of a skilled workforce who can design and build traditionally with stone. Many historic stone buildings today are not maintained correctly due to a lack of understanding of how stone functions in a building.

The aim of the SSLG project is to address these issues by providing a clear understanding of the extent of the problem by undertaking a 'stone health check' of the condition of Glasgow's stone buildings, and estimate of the amount of repair work that will be required. Only once these have been quantified, will it be possible to predict the level of stonemasonry skills and training required, as well as addressing the issues of stone supply (sandstone type and quantity) to ensure the future viability of Glasgow's stone built heritage.

1.3 PROJECT BRIEF (AIMS AND OBJECTIVES)

Project B: 'Buildings Health Check' consists of two main parts:

1. Survey of the condition of c.230 traditional stone building facades, where stone has been used as a load-bearing material.

2. Petrographic analysis of stone samples from c.100 surveyed buildings.

The aims of the buildings health check project are to:

a) Provide data and information that will determine the state of decay (or 'health') of the stone comprising the facades of representative buildings in Glasgow.

b) Determine the need for and quantify the volume of replacement stone to match the characteristics of the original stone.

c) Develop a comprehensive database of the natural stone present in the surveyed facades, including details of the stone characteristics.

The following elements of the study are required:

1. To design a methodology and recording pro forma for the survey of stone facades for a total of approximately 230 buildings (circa 100 'Landmark' and 130 'Other' buildings -see section 2.1 below for definitions of these terms).

2. Selection of a sample of ‘Other’ buildings to be surveyed that is representative of the stone-built heritage, based on the following criteria; age of building, geographical distribution, stone type, building type, facade orientation etc.

3. Conduct visual surveys of the stone on the selected building facades estimating the extent and condition of any existing plastic repairs to the stone and other factors affecting the condition of the stone. Surveys are to be conducted from ground level using a digital camera and binoculars/telescope for higher level examination. A digitised record will be made of the stone decay on each facade.

4. Extraction of small diameter core samples from circa 100 ‘Landmark’ buildings for microscopic examination and petrographic characterisation. The samples are to be archived and retained in the BGS national geoscience collections as a permanent record.

5. Analysis of the results from facade surveys and stone samples in order to provide a comprehensive record and database to form part of the archive of information on Glasgow’s stone buildings.

6. Production of a report on the findings of the facade surveys and stone analyses, providing an estimate of the likely need for stone repairs to the surveyed buildings over the next 20 years and an estimate of the volumes of different stone types that will be required. These data are to be extrapolated to provide an estimate of the likely need for stone repairs and volumes of stone that will be required to maintain the City of Glasgow’s stone-built heritage over this period. In addition, the identification of suitable matching stone types for future repairs is to be given.

The outcomes of the BGS research as listed above are presented in this report to the SSLG. These data are to be used by the SSLG to provide a report to the sponsors of the project to address the aims of the project as described at the start of this section.

1.4 PROJECT MANAGEMENT AND STAFFING

Projects A and B were managed and overseen by the SSLG-appointed project director, Dennis Urquhart. An official Steering Group consisting of a panel of invited experts was convened by the SSLG periodically during the project in order to review and approve progress. Those who have contributed to the BGS work presented in this report are listed below, together with their main areas of responsibility:

<u>BGS Staff</u>
Dr Ewan Hyslop BSc, PhD (Geology), MSc (Architectural Conservation), Chartered Geologist. BGS project leader, methodology development, facade surveys, petrographic analysis.
Mr Andrew A McMillan, BSc, Chartered Geologist. BGS internal project advisor and reviewer, member of SSLG Steering Group.
Mr Luis Albornoz-Parra, BSc (Geology). Methodology development, facade surveys, digital survey images, macroscopic analysis.

Miss Lydia Fisher BA (Archaeology). Building survey sheets, data analysis, historical buildings data.
Miss Leigh-Anne Baker BSc (Environmental Science). Buildings count, sample description sheets.

External Collaborators
Mr Alex Stark (SSLG Board Member and chairman of the Scottish Committee of the Stone Federation GB) appointed by Steering Group for calculation of stone quantity and mason time and skill requirements.
Miss Sarah Hamilton BSc (Geology), postgraduate student in Architectural Conservation,. Buildings count research and survey.

The BGS team acknowledge assistance from the following people:
Nikki Smith, Paul Henny, Keith Herbertson and Amelia Pickering (BGS Information Systems) for assistance with ArcMap GIS and Master Map software. Jane Robertson and Siobhan Gilliland (BGS Computing) for support with computer hardware and data management. Fergus MacTaggart and Brian McIntyre (BGS Photography) and Roy Fakes (BGS Petrology) for sample registration. Helen Bonsor (undergraduate geology student, St Andrew's University) assisted with fieldwork and sample registration.

1.5 PRESENTATION AND LAYOUT OF THE REPORT

1.5.1 Report Structure

As outlined earlier, the objective of this project is to undertake facade surveys and analysis of stone samples in order to provide quantitative information on stone quantity and mason-time and skills-level requirements for the future repair and maintenance of the stone built heritage of Glasgow. This report presents the results of the project and details the methodology developed and used to achieve these results. The full data are presented in a series of Appendices, and summarised in tables at the back of this report.

The report is presented in four main parts:

- Text Report and tables (this section);
- Appendix 1 'Results of facade surveys for 'A' buildings list';
- Appendix 2 'Results of facade surveys for 'B' buildings list';
- Appendix 3 'Petrographic analysis of stone samples from buildings'.

The text report contains details of the background and objectives of the project and the project brief. It describes the detailed methodology developed and used to undertake the various stages of the work, in particular the facade surveys, presentation and classification of stone decay data, stone sampling and petrographic analysis, calculation of stone quantities and mason time requirements and the buildings count survey. Separate tables list the surveyed facades, the codes used to classify stone decay, stone samples obtained from buildings, historic quarry sources of stone used in Glasgow, and the results of the stone quantity and mason-time and skill-level requirements.

Appendices 1 and 2 present results for each surveyed facade in the form of an individual building survey sheet with a colour image of the facade, showing digital overlays of the stone decay categories which were used to calculate the stone quantities and mason-day levels presented in section 4 of this report. Appendix 3 is a series of sample description sheets giving the results of the petrographic analysis of the building stone samples which provide the data used in section 3 of this report.

1.5.2 Nomenclature of stone –'red' and 'blonde' sandstone

In this report the two main types of sandstone used as building stone in Glasgow are described using the terms 'red sandstone' and 'blonde sandstone', as used by previous workers (e.g. Bluck & Porter 1991; Glasgow West Conservation Trust 1993). Red sandstone is generally taken to mean sandstone of Permian and Triassic age which was imported into the city largely from Ayrshire and Dumfriesshire from the late 19th century onwards, following the introduction of the railway system. Some geologically older red sandstone was used from Carboniferous and Devonian deposits in the Glasgow area, but it is typically more variable in colour and texture (see sample descriptions and discussion of quarries in section 3).

Blonde sandstone (also known as white or cream-coloured) is the traditional name used in Glasgow for pale coloured sandstone of Carboniferous age, typically obtained from local quarries in the Glasgow area and adjacent parts of the Scottish Central Belt (e.g. Lanarkshire and Stirlingshire). At the current time, most pale coloured building sandstone is referred to in the UK building trade as 'buff sandstone'. However this term is deliberately not used in this study as it more accurately describes the relatively iron oxide rich (and therefore more strongly coloured) Carboniferous sandstones from northern England which currently dominate the UK market. Although they show some variability, the blonde building sandstones used traditionally in the Glasgow area have distinct characteristics which justify the use of the term 'blonde' (see section 3 for further discussion).

2. SURVEY OF STONE FACADES

2.1 SELECTION OF FACADES FOR SURVEY

The facade survey element of the project requires that c.230 stone facades are surveyed and assessed for stone repair requirements. The surveyed buildings were drawn from two lists, 'Landmark' buildings (referred to as 'A' buildings) and 'Other' buildings (referred to as 'B' buildings). It is important to note that the use of the prefix symbols 'A' and 'B' do not relate to the statutory listing of buildings by Historic Scotland. The symbols are used here solely in order to distinguish the two main building lists, as described below. Information on the listed status of buildings can be obtained from the Historic Scotland website.

The BGS was presented with a list of so-called 'Landmark' buildings for which permission to survey and sample had already been obtained by SSLG. These buildings are all Listed Buildings of historical/architectural merit which are considered to be significant to the stone built heritage of the city. A total of 112 Landmark buildings were selected for inclusion in the 'A' building survey list.

In order to achieve the overall total of c.230 facade surveys, a further 118 stone facades were needed to be selected from the 'Other' buildings list (i.e. 'B' buildings). As outlined in the introduction, these buildings were required to be selected by BGS in order to be representative of the stone-built heritage in Glasgow, based on criteria such as age of the building, geographical distribution, stone type, building type, facade orientation etc.

The list of 'Other' buildings is intended to be a representative sample of the variety of stone buildings throughout the entire city. This is a difficult task given a total sample size of c.230 buildings out of an estimated population of over 24,000 stone facades in the city as a whole (see buildings count below). In addition the sample from the pre-selected list of Landmark Buildings, compiled from Historic Scotland's Listed Buildings, is heavily biased in favour of churches (51%) and schools (42%). Given these constraints there are limitations on how representative the total 230 surveyed facades can be in terms of the overall stone built heritage of the city.

No data are available for the proportions of different building types within the population of stone buildings in Glasgow (for example the percentage of residential buildings, schools, churches etc.). Despite enquiries to the Mitchell Library, the City Council and Historic Scotland, no sources of such information could be identified. Likewise there are no overall data concerning building age, stone type, facade orientation etc. that could be used to help select a representative set of 'Other' buildings. In order to generate such detailed information an extensive additional survey programme would be required, beyond the time and budgetary constraints of the current project.

In order to address the issue of selecting representative buildings a pragmatic strategy was developed in order to ensure that the sample of 'Other' Buildings (the 'B' list) included a range of facades corresponding to the stipulated criteria above, and which are as representative as possible. During the surveys of Landmark Buildings observations were made of different parts of the city in order to establish what types of buildings are representative of specific areas. For example, terraced residential properties and ‘high-status’ tenements are characteristic of several western parts of the city (e.g. Hyndland and Dowanhill areas), whilst relatively plain high-density tenement properties are characteristic of areas such as Tollcross and Shettleston. In addition, the majority of these buildings (but by no means all) in the western areas are built of blonde sandstone, whereas in Tollcross and Shettleston red sandstone predominates. In contrast, it was possible to identify pockets of older, more ‘vernacular-type’ buildings surviving in a number of areas (representing pre-existing settlements subsequently incorporated into the City of Glasgow), for example in Baillieston. Other parts of the city are more characterised by industrial or commercial premises, for example Tradeston and Kingston.

In this way it has proved possible to build up a picture of the range of stone building types in different parts of the city, as well as patterns of building age and stone type. The development of different parts of the city at different times has resulted in the use of varying stone types, such that local blonde sandstone predominated in the earlier buildings, whereas many later developments used red sandstone.

It was also considered important to ensure that the surveyed buildings are representative in terms of the condition of stone. Again, during the surveys of Landmark buildings it was possible to observe the general condition of buildings in a particular area, so that buildings selected for the ‘B’ list were representative. For example, prior to selecting a particular tenement facade in an area, a ‘walk-through’ of the neighbourhood was carried out to establish the average condition of the buildings. Likewise a variety of facade orientations were selected in order to provide a representative sample of orientations.

In order to be representative of the range of building types throughout the city a conscious attempt was made to identify and survey buildings of different types. These are divided into seven general categories, and are identified for each building on the individual building survey sheets in Appendices 2 & 3. The different groups are:

- (i) Residential (e.g. tenement, terrace, detached villa, cottage)
- (ii) Commercial (e.g. shops, banks, offices)
- (iii) Industrial (e.g. warehouse, factory, agricultural)
- (iv) Church (including disused or former church)
- (v) School (primary or secondary education)
- (vi) Public buildings (e.g. library, swimming baths, municipal, hospital etc.)
- (vii) Monuments (e.g. archways, memorials etc.)

Additionally, a number of historical heritage structures were included such as Pollock House and Povanhall House, both in the care of National Trust for Scotland, and buildings such as the Daldowie Doocot and Castlemilk Stables, both of which are heritage and community attractions run by Glasgow City Council. A number of stone monuments were also included such as arched entranceways (e.g. McLennan Arch at Glasgow Green), and several memorials from the Glasgow Necropolis. The inclusion of these structures in the sample was intended to ensure that the results of the project are of direct relevance to buildings and structures already recognised for their heritage value.

In summary, despite the sample of surveyed facades in this study representing less than 1% of the total population of stone facades in the city, every practical effort has been undertaken to ensure that the buildings selected were representative of the range of building types, age, stone types, orientation and other relevant factors required to provide a valid sample of the stone built heritage in Glasgow. The total number of 'Other' buildings selected for the 'B' survey list was 122, bringing the total number of surveyed facades to 234. Tables 1 & 2 list the 'A' (or 'Landmark') buildings and 'B' (or 'Other') buildings, respectively.

2.2 SURVEY METHODOLOGY

2.2.1 Photography of facades

All the surveyed facades were photographed using digital cameras, selected on the basis of image quality, ease of use and portability. Two cameras were employed for the survey work, a Canon PowerShot S60 with 5.0 Mega Pixels, and a Fuji FinePix 6900 with 6x Optical Zoom and 5.0 Mega Pixels. The Canon was used for most facade images as it has a wider angle lens, whilst the Fuji was used for photographing details at high levels on facades as it has a more powerful zoom function.

The images were recorded in 'jpg' format, typically in the range 1500 to 2000 Kb file size. All the images used are registered in the BGS Geoscience Imagebase where they are archived in digital form and available for future reference through the National Archive of Geological Photographs. Weather conditions at the time of survey were recorded on the Building Survey Form (see below).

2.2.2 Processing of facade images

Following the field survey, images were selected for processing to produce the digital facade images. For some facades a single image was taken but in most cases it was necessary to join several photographic images together to create a composite facade image. Following registration, the selected images were corrected for lens ('barrel') distortion and rectified in order to correct for perspective using commercially available photographic software. Where required, images were 'digitally stitched' together to form composite facade images. The composite images were digitally converted to black and white 'line-drawing' images and printed at A3 size and taken into the field where the decayed areas were marked directly onto the printout as part of the facade survey.

Following the survey, the images were imported into ESRI ArcMap 9 Geographic Information System and geo-rectified to a corrected scaled image using a scale measurement made on the building during the facade survey (see below). Once geo-rectified, the areas of stone decay on the building were digitally traced as layers onto the images, assigned a decay code, and the surface areas automatically calculated (in metres^2). The completed digital images were then passed on to the stone masonry consultant Alex Stark, for calculation of stone quantities and mason time requirements (see Chapter 4). An example of a completed digital image following facade survey is shown in Figure 1.

2.2.3 Pro forma recording sheet

The pro forma survey sheet (termed 'Building Survey Form') was designed to allow systematic collection of information in the field in order to provide the data required for the facade surveys. One A4-size double-sided sheet was produced for each building, designed to be used in the field on a 'clip-board', and completed by hand. The information recorded on the pro forma was then used to compile the building survey sheets and in production of the digital survey images (Appendices 1 & 2). An example of a completed Building Survey Form is reproduced as Figure 2.

Figure 1. Example of composite facade image, corrected for distortion, scaled (georectified), showing digital overlays of stone decay types and repair requirements.

The pro forma was designed to give maximum flexibility whilst ensuring a consistent approach to the recording of data from facades. Most of the categories shown on the sheet are self-explanatory, although a number are explained below:

'**Area/Number**' For the purposes of the fieldwork the city was divided into six arbitrary geographical areas, Central, South, Southwest, West, North and East. Number refers to the unique building number ('A'-list and 'B'-list) issued to each surveyed building, as presented in Tables 1 & 2.

'**Type**' is the original building function, e.g. school, church, tenement, villa etc. For buildings which have changed use it is the primary function for which the building was constructed that is recorded. If a building is unoccupied, or derelict (i.e. incapable of being occupied without significant repairs), this is also recorded.

'**Environment**' records the exposure of the facade (e.g. sheltered by trees etc.) and the ground conditions at the foot of the building (e.g. concrete paving, gravel etc.)

'**Masonry style**' is a summary of the type of stone block used (e.g. squared rubble, ashlar etc.), the presence of courses, and style of surface finishing (e.g. rock faced, broached, smooth etc.). Terminology follows standard Scottish traditional building practice, and that described in Pride (1996).

BGS SAFEGUARDING GLASGOW'S BUILT HERITAGE: BUILDING SURVEY FORM

Date/Surveyor 25/6/05 EKH Area/Number EAST / A137

Building Name/Type SPRINGBANK LIBRARY /PUBLIC

Address 125 Scotshill Street, Springbank

Façade Orientation/Environment South / Concrete pavement to busy street

Brief Description Single storey with 3 arch windows in centre and doorways to either side with pilasters. Dentilated cornice

Weather Conditions (light/damp/rain etc.) Weak sun, dry.

Masonry Style Smooth ashlar with moulded details. Stugged base course

Stone Description (type/location/grainsize/colour/texture/others)
Blonde sandstone with common planar bedding and rare cross-beds. Medium to coarse grained with common dark brown mud flakes <5cm in size. Pale cream colour weathering to variable orange.

Problems (location/type/notes)
SD to lower parts of base course and around entrances. BWs to occasional ashlar blocks, esp. upper LHS, due to former water penetration – some blocks here require <20 years replacement, most >20 years
Cornice at LHS and underlying courses DP + BCm. Gutter blocked RHS BCh. Minor relief weathering Rsb to many blocks at upper levels but no replacement required. Damaged stone due to PR to central arch window dressings. FSi to cill on LHS window – <20 year replace.
RR needed for much of facade
RHS corner above base course BOa to ashlar (damage by vehicle strike)
CLp – evidence of abrasive cleaning from loss of surface and moulded details – no replacement required.
PTO sketch showing BWs, PR + DP.

☐ Crust ☑ Scaling ☐ Crumbling ☐ Face Bedding ☐ Splitting ☐ Plastic repair ☐ Cement pointing
☐ Salts ☑ Urgent maintenance ☐ Previous stone repair ☑ Requires repointing ☑ Damp
☐ Severe Soiling ☑ Cleaning: ☐ Chemical ☑ Abrasive ☑ Cracks ☐ Subsidence ☐ Guano
☑ Measurements: ☑ Sample: core taken from damaged block below RHS window
LHS window 245 x 107cm
" " cill 149 x 20cm

Is façade representative? Yes Façade proportion of building 1/3

Figure 2. Example of a completed Building Survey Form, as used for all the facade surveys.

‘**Stone description**’ is the type of stone present (e.g. red sandstone), with a general field description of the stone based on observations of masonry blocks in the building (e.g. grainsize, colour, textural variation etc.)

‘**Problems**’ This large section is to record observations of stone decay, maintenance issues, mortar condition and other relevant factors such as water penetration, presence of graffiti, guano etc. Information is recorded as a series of shorthand ‘Stone Decay Codes’ devised for this project, and described in the next section below. These are summarised as series of tick-box prompts at the base of the sheet. Normal practice was to systematically record observations of particular elements of each facade.

‘Measurements’ For each facade at least one significant element of the building was measured (e.g. an entranceway or window opening, and a typical masonry block size) in order to provide a known areas for georectification of the digital image to allow automatic calculation of surface areas of marked-up areas of decayed stone. These measured areas are visible on many of the images of surveyed building facades in Appendices 1 & 2, commonly as uncoloured areas of hatching over doorways and windows. The rear of the survey sheet has room for additional information and sketches if required.

2.2.4 Decay categories

The types of stone decay and related features affecting the condition of stone on facades as recorded on the pro forma survey sheets and the digital facade images are presented in Table 3. These ‘decay categories’ are presented as a series of codes which have been devised specifically for this project, representing forms of decay that are of particular relevance to the aims of this study, and significant to stone buildings in Glasgow. The scheme is based on published work by internationally recognised experts, in particular Fitzner & Heinrichs (2002) and Esbert et al. (1997). These published works are designed for in-depth condition surveys of individual monuments involving much more detail than is appropriate for this project. The decay scheme adopted for this study is therefore a more simplified version, based on the main decay categories.

Individual ‘**Stone Decay Codes**’ in Table 3 are divided into a series of headings (for more detail see Fitzner & Heinrichs 2002, and other publications by these authors):

- (i) ‘**Loss of stone material**’ where stone material is physically eroded from the stone masonry, with three subcategories, back weathering and surface detachment, relief weathering, and break-out (loss of competent stone fragments).
- (ii) ‘**Discolouration and surface deposits**’ covers colour changes, painted masonry, soiling, salt deposits, crusts and biogenic colonisation.
- (iii) ‘**Fissures and deformation**’ cracks (non-natural fractures) and evidence of structural movement.
- (iv) ‘**Others**’ is a broad category including cement ‘plastic’ repairs and pointing, open masonry joints where repointing is required, previous repairs (stone or other materials), missing stone, physical damage resulting from stone cleaning, and moisture penetration (damp).

2.2.5 Stone repair and maintenance requirements

As described above, the digital images of surveyed facades are marked-up with digital overlays showing the stone decay type as a series of decay codes. Each area of stone decay on the facade is highlighted by a block of colour, with different colours and patterns representing different degrees of urgency or types of action required. The key to the colour symbols is shown on each digital facade images in Appendices 1 & 2, and is reproduced below as Figure 3.

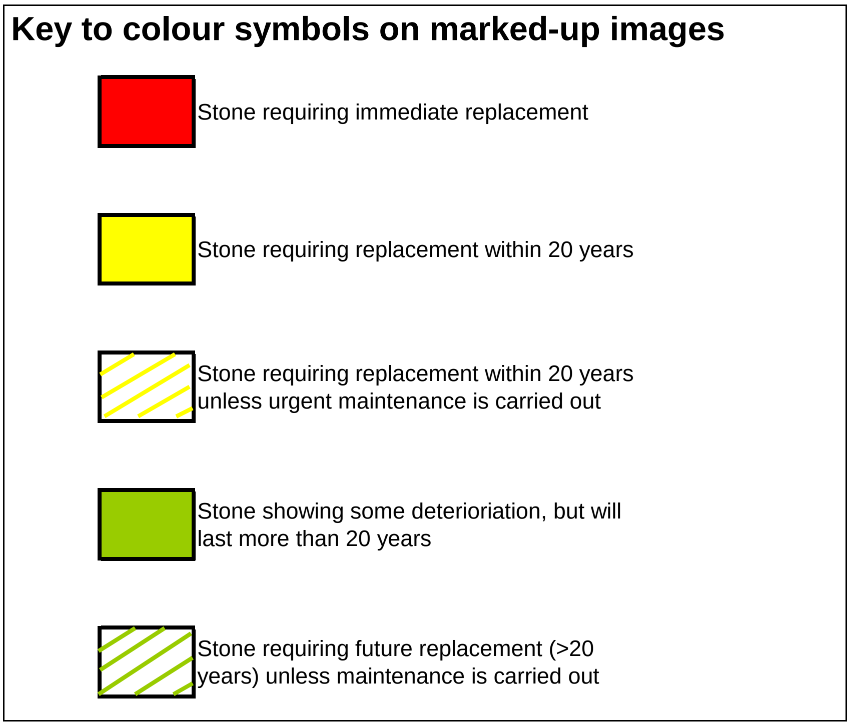


Figure 3. Colour symbols used on the digital facade images, showing categories of repair and maintenance identified.

Solid colours indicate that stone replacement is required. Red colour signifies that in the opinion of the surveyor (see section 2.2.6) urgent repair (or attention) is required, and is used to signify stone which is regarded as physically unstable (i.e. with a risk of failure in the immediate future). In many cases where red is used it signifies the presence of cement repairs or patches which are considered to be at risk of failure. Yellow colour indicates stone which the surveyor has judged to be decayed or damaged, or in the process of decay, such that it will require replacement within the next 20 years. This includes stone which at the time of the survey requires replacement, but is not considered urgent in terms of its physical stability. Green colour signifies stone which is showing signs of decay or more minor problems (e.g. soiling), but which is judged to be able to perform satisfactorily for at least 20 years, although it may need replacement at some point beyond that time. As the objective of this project is the calculation of stone volumes and mason skills requirements within the next 20 years, only red and yellow coloured areas are included in the calculations.
Two subsequent colour codes are used which have a diagonally hatched ornament. These both indicate general areas of stonework where it is considered that attention or maintenance is required if future decay of some of the stone is to be prevented. Yellow hatching is used to highlight an area where it is considered that damage will

occur to the some of the stonework within 20 years unless maintenance is carried out. Green hatched ornament is used where it is judged that that stone damage within the area may occur over a longer (>20 year) timescale unless maintenance is carried out. As with areas of stone decay, each area highlighted as requiring maintenance has a 'decay code' showing the type of maintenance required or the issues that need to be addressed. Most immediate maintenance is related to saturation of the stone by water due to, for example, a failed gutter or downpipe. Examples of less urgent maintenance issues are where repointing is required or if bird guano deposits are present on the stone. The hatched areas are intended to highlight specific issues mostly related to building maintenance. They are not intended to provide quantitative predictions of volumes of stone required for future repairs.

2.2.6 Criteria for decision-making for the stone surveys

The objective of the facade surveys, as outlined in the introduction to this report, is to provide quantitative data on the amount of stone requiring replacement **within the next 20 years**, so that both the volume of stone and the masonry skills requirement can be calculated. The primary aim of the survey work was to assess the condition of the stonework and to make a judgement as to which parts will require replacement within the next 20 years (including that requiring replacement at the time of the survey). It is not the purpose of this study to identify unsafe masonry or other materials (e.g. asbestos) which may constitute a risk to health and safety, nor to comment on other issues such as structural stability which would constitute a building survey. In order to ensure consistency and to clarify the decision-making process, the following points are made:

1. The facade surveys were undertaken by only two members of the project team, both of whom have training and previous experience of assessing the condition of building stone (Dr Ewan Hyslop has an MSc in Architectural Conservation, and Luis Albornoz-Parra has a BSc and post-graduate experience with the building stones research group at University of Oviedo in Spain).
2. Although throughout the project most surveys were carried out by a single surveyor, in order to ensure a consistent and agreed approach the early surveys were undertaken jointly by both surveyors. Throughout the project discussions took place in order to agree decisions, and joint visits to buildings continued to the end of the project to ensure consistency.
3. The decision to identify stone as requiring replacement within 20 years was constrained by a number of specific criteria:

(i) Unsafe stonework at risk of failure or which is likely to become unsafe.

(ii) Functional stone elements which are failing to perform e.g. damaged cornices, hood mouldings and other features designed to protect the building from water).

(iii) Stone masonry showing structural damage (e.g. cracked lintels, areas of structural subsidence).

(iv) Stonework where the integrity of the block is decayed or damaged such that the surrounding masonry is at risk from exploitation of the damaged area by weathering processes (e.g. where a block or part of a block has eroded back to an extent that further water penetration, frost action etc. will risk accelerating the decay to surrounding masonry).

(v) Stonework is decayed or damaged such as to have a significant impact on the aesthetics and architectural value of the facade, including requiring the reinstatement of missing masonry and carved details.

(vi) Where it is judged that the stone is so badly damaged that deterioration will occur over the next few years that will result in any of the above factors.

(vii) Where cement based plastic repairs have been used which are showing evidence of damage to underlying or adjacent stone and/or are at risk of failure. (Note that where thin surface ‘skins’ of render are present over stonework which is in reasonable condition these have been identified as a maintenance issue requiring removal by the site mason, even though stone replacement may not be required).

It is accepted that there is a degree of subjectivity to the decision-making process outlined above. Although it is possible that if the surveys were repeated by different surveyors, they may elect to use a different set of criteria, it is hoped that by setting out the points above, the decision-making process used in the present study is clear and understandable. The remit of the project is to identify and quantify stone masonry which will require replacement within 20 years. Because stone decay is determined by a number of complex factors and interactions, there is clearly a degree of interpretation in making such predictions, and it has to be accepted that this process cannot be totally accurate. However, it is considered that using the approach described above, the results from this study are likely to be as accurate as is practicable within the constraints of the project.

In summary, the decision to replace stone is guided firstly by functional and structural requirements, and secondly to preserve to a reasonable degree the original visual architectural intention of the facade. It is not the purpose of this study to propose reinstatement of the masonry in order to produce a pristine facade which appears exactly as it was when originally constructed, but rather to repair the building so that it has both the functional capability to survive in the future, and retains the essential aesthetic elements of its original design.

It might be agued that the results from this study present an ‘idealised’ level of stone repairs whereas in reality, for budgetary reasons or otherwise, many repair projects would elect not to undertake all the stone repairs that have been identified. For many projects it is common for some areas of stone decay not to be replaced, and these stones may be left, redressed or ‘dressed-back’ to remove loose and decayed stone, or subject to plastic repairs. Even if this is the case, it is argued that the approach taken in the study at least presents a consistent benchmark against which future repairs programmes can be assessed.

The visual and petrographic surveys undertaken during this study do not constitute a building survey as undertaken by a professional surveyor. The work considers only the surficial condition of the stone masonry. The results of these surveys should not be linked, or considered to effect, the monetary value of the surveyed buildings.

2.3 DISCUSSION OF RESULTS

The results of the facade surveys are presented in Appendix 1 ('A' buildings) and Appendix 2 ('B' buildings) where the survey results are given as a single data sheet and marked-up A4 colour digital image for each building. The sheets summarise the main features of the facades including masonry details and types of stone decay and related observations. The areas of stone decay and maintenance requirements appear as coloured overlays on the images using the stone decay codes described earlier.

2.3.1 General features of the surveyed facades

The variety of building types surveyed from the 'A' and 'B' building lists is illustrated in Figure 4. The relatively high proportion of Churches and Schools is because of their dominance on the 'A' buildings list as discussed previously. The Residential group is also relatively high (comprising almost a quarter of the surveyed facades) because the category includes a range of building types (for example high density tenements, terraced houses, detached villas and others). The other groups (Public Buildings, Commercial, Industrial and Monuments) are fairly evenly represented. The plot indicates that the facades included in the survey represent a broad range of building types from the stone heritage of Glasgow.

Figure 4. Surveyed facades: building type

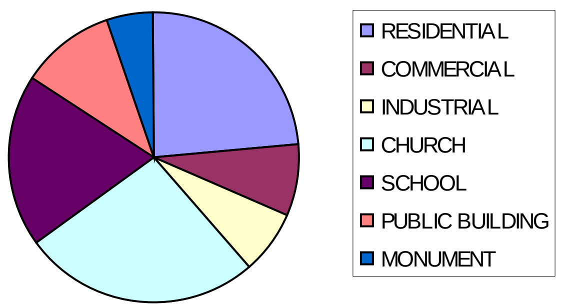


Figure 5 shows the orientations of surveyed facades from the Building Survey Forms. There is a fairly even spread of orientations with a predominance of south, north, east and west orientations which reflect the approximate orientation of the street grid pattern throughout much of the city. The greater number of facades with a southerly orientation is because many of the more 'prestigious' listed buildings in the 'A' list have their principal elevations facing south.

The plot of stone types in the surveyed buildings (Figure 6) shows the dominance of blonde and red sandstone, with a relatively small proportion of other types (mixed red and blonde sandstone, mixed sandstone and other types of stone, brick with stone dressings, and granite).

Figure 5. Orientations of surveyed facades.

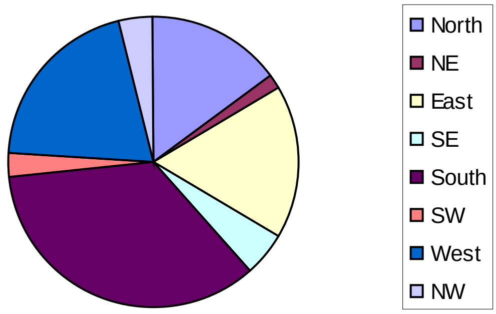
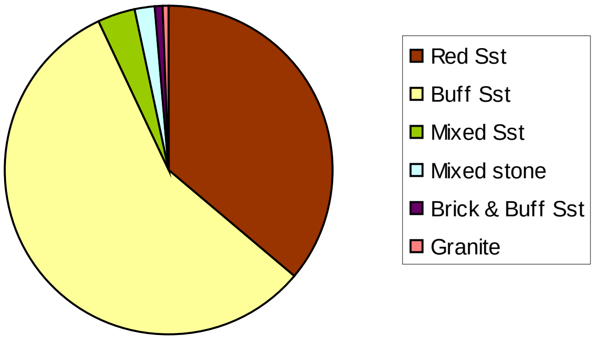
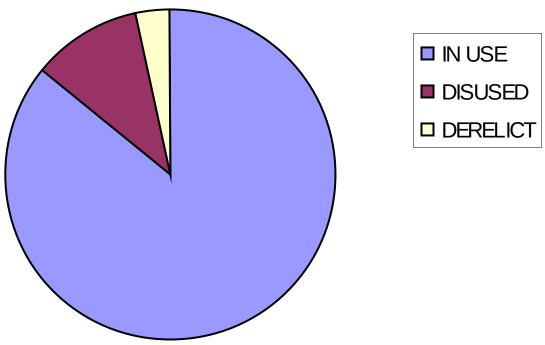


Figure 6. Stone types in surveyed facades



The relatively high proportion of schools and churches in the ‘A’ buildings list has resulted in over-representation of red sandstone in the surveyed facades. The majority of the churches and schools were constructed in the late 19th and very early 20th centuries, when red sandstone was being imported into the city and was commonly used for such buildings. Prior to c.1885 buildings in Glasgow were almost exclusively constructed from local blonde sandstone (Glasgow West Conservation Trust 1993). For the ‘A’ list 39% of facades are red sandstone and 55% are blonde sandstone. The ‘B’ list has 32% red sandstone and 60% blonde sandstone. Based on observations during the selection of buildings and the buildings count (section 4.1), the latter distribution is considered to be more representative of the city’s stone buildings.

Figure 7. Building status



The plot showing building status (Figure 7) shows that most of the surveyed buildings were occupied or in use at the time of survey, with a relatively small proportion of disused buildings (11%). A much smaller proportion of surveyed buildings were noted as derelict (i.e. require significant repairs before capable of occupation). These figures broadly indicate that the majority of stone buildings in Glasgow are currently in use and form an important part of the city’s active building stock.

2.3.2 Summary of the stone decay in surveyed facades

Results from the facade surveys presented in Appendix 3 suggest that there are a number of common mechanisms of stone decay occurring in the facades, irrespective of whether the stone is red sandstone or blonde sandstone. In general, environmental and anthropogenic factors (including location of stone in a building and orientation) are significant factors in determining the type and extent of stone decay. For example, crust formation and granular disintegration are both commonly located in sheltered areas of facades where evaporation of water is restricted.

Damage to stone resulting from exposure to air pollution (which can be determined by building location and facade orientation) has in many cases resulted in subsequent stone cleaning and plastic repairs. Both these activities also appear to result in stone decay (although they were probably undertaken in the first place because the stone was already damaged). Cleaning of sandstone by both abrasive and chemical methods has commonly resulted in the loss of the original outer surface of the stone revealing a relatively soft demineralised subsurface stone that is prone to granular disintegration. In many cases chemical cleaning appears to have resulted in discolouration of the stone surface, with blonde sandstone showing a range of effects from variable strong orange-brown colours caused by mobilisation of iron and other oxide minerals, to dull uniform grey colours caused by bleaching. The variability of damage caused by stone cleaning suggests that the application of different cleaning methods by different operators have resulted in different degrees of damage.

The presence of cement-based ‘plastic’ repairs has resulted in stone decay by trapping moisture (and in some cases salts) beneath impervious cement coatings and/or focussing moisture movement at the margins of such repairs. The weakening of stone underlying many plastic repairs has resulted in the cement materials becoming detached or physically unstable, whereas the stone itself tends to decay by granular disintegration. These effects appear to occur irrespective of whether the stone is red sandstone or blonde sandstone.

Lack of building maintenance is another significant cause of stone decay. This is mostly due to water penetration into the stonework from failed water dispersal elements such as broken gutters, blocked downpipes and damaged water-shedding features (e.g. cornices). Saturation of the stone typically results in erosion of mortar and opening of joints, which are then exploited by plant growth. Biogenic soiling is common on saturated stone. Stone which appears to have been subjected to water saturation for some time (on the order of several years) commonly shows evidence of accelerated decay from repeated wetting and drying cycles by granular disintegration and erosion of soft beds and enhanced development of surface scaling. In some cases salts are also present in saturated stone, with enhanced decay by granular disintegration concentrated in the wetting and drying zone normally at the extremities of the saturated area.

Water penetration to stone is also observed on prominent architectural features and projecting detailing such as string courses, many of which are designed to shed water from the building face. These areas are typically subjected to more wetting and may require repointing and have biogenic growth. Other sources of water penetration are present from the ground (e.g. rising damp) and from water-splash which is usually related to the presence of hard paving materials placed up to the building face. The common use of winter de-icing salts on paving surfaces and entrance steps has led to stone decay of the lower courses by scaling and granular disintegration due to uptake of water with salts in solution.

Splitting of stone blocks along bedding planes occurs in both red or blonde sandstone masonry, although is much more frequent in red sandstone which is more commonly bedded. Relief erosion of soft beds and cavities is occasionally observed in both red and blonde sandstone.

Scaling of stone occurs in both red and blonde sandstone, but appears to be more extensively developed in blonde sandstone. This is likely to be the result of the different mineral composition and porosity characteristics of the two sandstone types (see petrographic analysis of samples in section 3). The red sandstones generally have a more siliceous composition with an open pore structure allowing relatively free migration and surface evaporation of water. The blonde sandstones contain variable proportions of carbonate, iron (and possibly manganese) oxide and clay minerals, which are relatively prone to dissolution and mobilisation, which can form a mineralised surface zone over a relatively depleted subsurface zone (c.f. Bluck & Porter 1991). The differences cause the blonde sandstone to develop more scaling and loss of surfaces, revealing a weakened underlying stone which is then prone to granular disintegration. In addition many blonde sandstone buildings are likely to be older than red sandstone buildings, therefore showing more advanced stone decay simply due to prolonged exposure.

Other significant, though less common forms of stone decay/damage is physical damage due to the presence of iron inserts which have expanded and fractured the stone masonry. Other fractures to masonry blocks are caused by structural factors such as subsidence (typically seen as broken lintels above openings).

Face bedded stone was observed in many buildings, and is much more common with blonde sandstone which is a freestone with little obvious bedding structures. Such blocks are identified as being face bedded by the alignment of mica flakes which are normally parallel to the bedding. Despite this, face bedding does not appear to be a primary cause of stone decay but it does exacerbate the scaling process and will cause relatively rapid failure of plastic patch repairs. Other less significant features such as guano deposits and graffiti are present on a few buildings.

3. ANALYSIS OF STONE SAMPLES

3.1 SAMPLING STRATEGY AND METHODOLOGY

The samples collected from surveyed buildings are listed in Table 4. All the samples collected in this project are sandstone. 126 samples of building stone were collected from 112 buildings. 77 samples were obtained from 'A' buildings, and 44 from 'B' buildings. Five additional samples are included from buildings which were not surveyed (identified as 'C' in Table 4). For a few buildings several samples were taken in order to characterise different stone types within the building, or to look at the range of stone compositions present. For a small number of buildings the samples were not analysed because the sample was too weathered or of insufficient quality for thin sectioning.

Where possible, effort was made to collect samples from 'B' buildings (see below) in order to increase the range and representative nature of the stone types examined in this study. As discussed earlier, the dominance of schools and churches in the 'A' building list, many of which were constructed within a similar time period, is likely to lead to an over-representation of a relatively limited range of stone types. In particular, the presence of 44 red sandstone buildings in the 'A' buildings list would bias the samples towards stone from limited number of quarries (since most of the red sandstone used in the city was imported from a very limited number of quarries operating in the Borders and Ayrshire). The broadening of the sample base has allowed more variety of stone types to be included, in particular the local blonde sandstone which was obtained from a large number of quarries in the Glasgow area, as well as representing stone types used in the city at different times.

Because many of the buildings surveyed are Listed Buildings, permission from Historic Scotland was required for the core sampling. A sampling methodology was drawn up by BGS and approved by Historic Scotland and Glasgow City Council such that individual listed building consents were not required. The agreed methodology set out for coring is given below:

1. Cores will only be extracted from buildings where permission has been given.
2. Cores to be extracted from parts of buildings where there will be minimal visual and no structural disruption. No core will be taken where it would result in an unsightly appearance or cause disruption in any way. In some cases (e.g. buildings which are currently undergoing repair) it may be possible to get access to core from the inside face of the stone so that nothing is visible on the facade.
3. Where possible, cores can be taken from similar stone from another less visible part of the building, or from already damaged or decayed stone (in particular for buildings which are currently undergoing or about to undergo repairs).
4. Cores will be less than 60 mm in diameter (normally using 45 mm or 35 mm drill bits) and less than 150 mm in length.
5. Coring will be carried out using a hand-held 110V diamond masonry drill operating from either mains supply or hand-held petrol generator.
6. As part of the project risk assessment a health and safety procedure has been drawn up for the coring exercise. Site safety plans will be followed where relevant. Coring

will only be carried out by BGS staff who are involved in the buildings survey project, and have been trained in use of the equipment.
7. Where necessary, cores will be plugged by using lime mortar and capping the hole using a part of the core. Care will be taken to minimise the visual effect of the coring.
8. Core samples will be labelled and, following analysis, registered in the archives of the British Geological Survey, where they will be available for consultation.

Samples were collected from buildings where permission was granted, and in all cases sampling was undertaken to produce minimal visual impact to the building. For many buildings it was possible to obtain a sample by collecting from already detached or damaged stone. In the case of rock-faced masonry it was sometimes possible to remove a suitable ‘chip’ sample using hammer and chisel leaving a surface indistinguishable from the original hammer-faced masonry finish, resulting in no visual impact to the building.

Sampling was undertaken in order to obtain stone which is as fresh and unweathered as possible. It is not the purpose of this study to investigate the decay processes occurring in the stone. Additionally, samples were chosen to be representative of the principal stone type used in a building (albeit constrained by sampling from ground level only). Both these factors are essential in order to fulfil the objectives of this study, i.e. to characterise representative original stone types used in the city in order to highlight issues of future supply of matching stone types for repair and maintenance of the stone built heritage of Glasgow.

3.2 SAMPLE DESCRIPTION PROCEDURE

The samples collected from buildings are listed in Table 4 which contains summary results from the sample analyses. The full samples descriptions and analyses are presented in Appendix 3 where each sample is described on a Sample Description Sheet in order to ensure a systematic approach, based on the procedure detailed in BS EN 12407:2000 “Natural Stone Test Methods – Petrographic Examination”. Each sheet is divided into four parts; Sample Information, Macroscopic Description, Microscopic Description and Sample Matches. The description of samples is not intended to be an exhaustive series of physical, chemical and mineralogical tests, but is intended to provide a systematic characterisation of each sample using relevant specified criteria, to provide a ‘fingerprint’ for identification of the original building sample and allow comparison with quarry samples in order to identify the original quarry source (where possible) and currently-available petrographic-matching stone types for future repairs. The overall aim of the characterisation of samples in this study is to establish which particular types of sandstone are required for the future repair and maintenance of Glasgow’s stone buildings, and whether the range of currently-available sandstones from active quarries are suitable to meet that need.

For ease of interpretation, the Sample Description Sheets in Appendix 3 are grouped into blonde sandstones and red sandstones, and the results are discussed in these groups below.

The sample information consists of building number, address and name of building, and sample number. All the samples collected in this project have been registered in the 'ED' collection of the British Geological Survey, and included in the 'UK BritRocks' database of geological samples. The samples and thin sections will be archived in the National Geoscience collections at BGS Edinburgh and are accessible for consultation on application to the BGS Collections Manager.

The Macroscopic Description (Appendix 3) consists of examination of the sample using a hand lens or binocular microscope. Samples were examined dry on fresh, unweathered surfaces following gentle washing with distilled water to remove any soiling or dust. Procedures follow standard methods and classification schemes from Pettijohn et al. (1972) and Tucker (1982). The description consists of General Observations, Colour (using the international Munsell colour system notation, Oyama, & Takehara 2002), Grainsize ('fine' = <0.25 mm; 'medium' = 0.25 to 0.5 mm; 'coarse' = >0.5 mm; 'granule' = >2 mm), Texture (uniform, bedded, laminated etc.), Composition (presence of distinct visual components such as quartz, feldspar, iron oxide, carbonate etc.), Grain Hardness (degree of friability = response to scratch test with a steel knife blade = 'strong', 'intermediate', 'soft', 'friable'), Grain Texture (surface observation of grain packing and cementation = 'tight', 'intermediate', 'open'), Water Absorption (indicator of permeability characteristics by speed of absorption of water droplet on a natural surface = 'rapid', 'moderate', 'slow', 'none'), 10% HCl Test (indicating presence of carbonate minerals by reaction with 10% hydrochloric acid on natural surface and powdered material).

Microscopic Descriptions (thin section analysis) in Appendix 3 were undertaken using standard 75 x 25 mm thin sections examined on a Zeiss Large Universal Research Microscope. Thin sections were prepared at the BGS thin section facility. Where possible the samples were cut perpendicular to bedding, and prepared from the least-weathered parts of the sample. The thin slices were impregnated with blue dye resin in order to highlight porosity in all the thin sections.

Thin section descriptions follow standard petrological practice and procedures from Greensmith (1978) and BS EN 12407:2000. The descriptions include: textural observations (uniform, bedded etc.), physical grain information (grainsize, roundness, sorting characteristics), compositional information and approximate proportions of major, minor and accessory components, and degree of compaction and cementation with porosity characteristics and pore infilling minerals. Secondary minerals and alteration are described where present, as well as any other significant features. The thin section image is shown to illustrate the main characteristics of each sample. All thin section images are c.3mm across and taken in planer polarised light, with porosity highlighted by blue dye resin impregnation.

'Stone Type' (shown in Table 4 and Appendix 3) is a classification or grouping given to each of the building samples using the results of the petrographic analysis (both macroscopic and microscopic). Comparison with specimens from historic quarry sources and currently-available stone types in the UK, held in the BGS collections, has allowed the establishment of six categories of blonde sandstone (Types B1, B2, B2a, B3, B4 & B5) and four categories of red sandstone (Types R1 to R4). These are described in detail in the respective sections below.

Where possible, in the case of the red sandstones the original quarry source of the sample is identified from petrographic characteristics ('Original Source Petrographic'). The original quarry source is named only where the physical macroscopic characteristics (dominantly texture and colour) and the microscopic characteristics (mineral composition, porosity characteristics etc.) give a clear match to historic quarry samples in the BGS collections. Some stone types have similarities to samples from more than one quarry, and in this case each quarry is listed. Where only some of the characteristics of a sample match those of a particular quarry sample, the quarry name is given and signified by a question mark. It should be stressed that these identifications are based on examination of only a single thin section, and may not be representative of all the stone in a building.

Petrographic identification of original quarry source is only given for red sandstones because these quarries are better documented than the blonde sandstone quarries. As noted earlier, red sandstone was imported into the city from c.1885 largely from a limited number of quarries in the Permian basins of Mauchline (Ayrshire) and Dumfries and Lochmaben (Dumfriesshire). Some 'red' sandstone was also obtained from Scottish Central Belt, from quarries in Carboniferous and Devonian sedimentary rocks. In contrast, the blonde sandstone used in Glasgow was obtained over a much longer time period from numerous (many undocumented) quarries initially in the city centre and within the city boundary (as now), and latterly from areas surrounding Glasgow and the entire Central Belt (Lawson 1983; Glasgow West Conservation Trust 1993; McMillan et al. 1999).

Where the original quarry source for a surveyed building is known from documentary evidence, this is given as 'Original Source (cited)' in Table 4 and in the sample description sheets in Appendix 3 where the reference source is provided. The cited quarry source may or may not agree with the petrographic identification. In the experience of the authors it is not uncommon for a documented quarry source for a building to be incorrect, suggesting that the specified stone type quoted in the reference was not the one actually used for the construction of the building. It is suggested that in many cases the petrographic match is a more accurate identification (effectively a 'fingerprint') of the original quarry source.

3.3 INFORMATION ON HISTORIC QUARRIES AND USE OF STONE

Table 5 contains information on historic quarry sources of stone used in Glasgow, as well as some data relating to use of stone in individual buildings. The information has been compiled from a number of published sources (Boyle 1909; MacGregor et al. 1925; Lawson 1981; 1983; Pevsner 1990; Glasgow Conservation Trust West 1993) and published information from stone companies. For the reasons stated in the previous paragraph, the authors of this report are not responsible for the accuracy of the information in this table.

The table contains information on c.175 individual quarries, just over 100 of which are from the Glasgow area and supplied sandstone to the city. All these local quarries are now closed. They range from major operations such as the Giffnock and Bishopbriggs quarries which supplied large volumes of stone to Glasgow and other areas, to smaller quarries which probably largely supplied local needs (e.g. Eastfield quarry which is recorded as having supplied stone to specific streets in Cambuslang and Rutherglen).

A number of quarries in the list are sandstone quarries in the north of England which, following the arrival of the railways, supplied stone historically to Glasgow, some of which are still in production (e.g. Blaxter and Black Pasture quarries). In addition a number of overseas sources of stone are presented at the end of the table.

The list of historic sandstone quarries in Glasgow has been used to identify samples held in the BGS collections, which have been used for comparison with the samples collected from buildings as detailed in the section below.

3.4 ANALYSIS OF THE STONE SAMPLES

The results of the petrographic analysis of the samples are presented in Appendix 3 and summarised below. The various stone types identified from the sampled buildings are compared with samples from historic quarries which supplied stone to Glasgow, and with currently available stone types from active quarries throughout the UK (British Geological Survey 2005). The results are discussed in relation to the availability of future supplies of similar stone types for repairs.

3.4.1 Analysis of blonde sandstone samples

The samples of blonde sandstones from buildings have been divided into six different categories, based on petrographic analysis and comparison with samples from historical quarries in the BGS collections. Each category is described in turn below. The historic quarries listed are those for which samples are available from the BGS collections. Other historic quarries are given in Table 5. Full descriptions of each of the sandstone samples are presented in Appendix 3.

Type B1

(i) Description

These are relatively ‘pure’ sandstones with a highly siliceous (quartz-rich) composition and few additional components, classified as quartz arenite (i.e. >95% quartz). They are generally medium to fine grained, with a very pale uniform grey-white colour, and minimal (if any) carbonate and clay mineral content. They correspond with samples from a number of former (historic) quarries in the Glasgow area and the surrounding region which are known to have supplied this stone type to Glasgow. These are:

Blochairn, Glasgow (can be banded)
Craigash, Milngavie
Craigleith, Midlothian
Dunmore, Stirlingshire
Humbie, West Lothian
Lochcraigs, Glasgow
Smithstone, Glasgow

This sandstone type is similar to the well known building sandstone from the West Lothian Oil-Shale Formation of the eastern Midland Valley (e.g. Lothians, Fife and Clackmannanshire; see McMillan et al. 1999). It appears to be distinct from most of the sandstone quarried in the Glasgow area (see Type B2 below). It is likely that most stone of this type would have been imported into the city by canal and railway (e.g. from the Humbie, Craigleith and Dunmore quarries).

Only one of the buildings sampled in this project has been shown to contain this type of sandstone (B131 Glasgow Cathedral; Figure 8). However, listings of these historic quarries in Table 5 indicates that some of Glasgow's most prestigious buildings were constructed from this stone type. It is possible that the high quality of this highly siliceous sandstone was recognised at the time of construction and it was selected in preference over the more commonly used (and lesser quality) 'local' blonde sandstone. The well known Craigleith sandstone, quarried and mainly used in Edinburgh, is of this sandstone type. Craigleith stone is also recorded as having been used for high quality paving in Glasgow University (Table 5).

Figure 8a. Sample of Type B1 sandstone from Glasgow Cathedral, showing typical very pale colour and uniform texture of this highly siliceous sandstone.

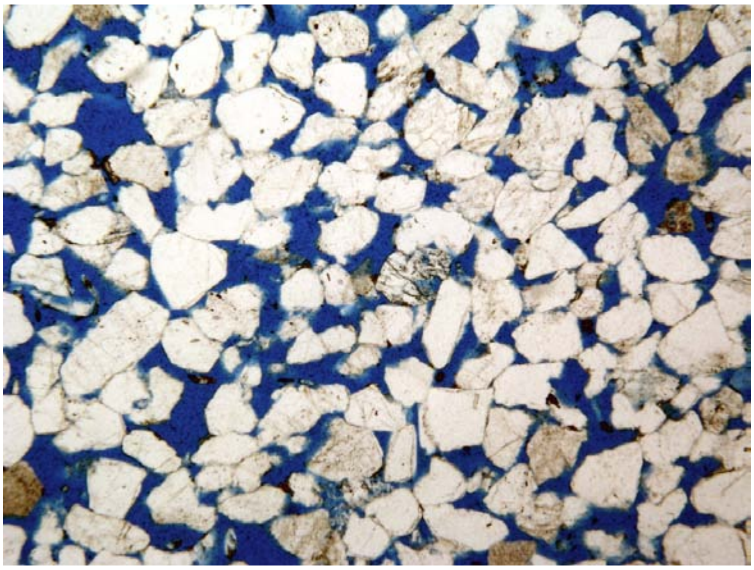


Figure 8b. Thin section image of typical Type B1 sandstone, showing quartz-rich, uniform texture with relatively high and open porosity. Porosity highlighted by blue dye resin. Image is c.3 mm across. (B131 Glasgow Cathedral)

(ii) Currently available matching stone

There are few quarries which currently produce such quartz arenite sandstone for building purposes. However, because of the importance of this sandstone in east central Scotland, Cullalo quarry in Fife has recently reopened to supply the conservation and repair market. Other reasonable similar matching currently available sandstones are from Clashach quarry in Moray (Permian sandstone), and Darney quarry in Northumberland (Lower Carboniferous). Note that the stone from both these quarries normally has a higher iron content and a buff colour, but it is possible to specify a paler (low iron) variety. A proposed quarry in Northumberland (Hazeldean) may also produce a similar sandstone.

Type B2

(i) Description

This represents the most commonly used type of blonde sandstone in Glasgow, and is typical of the Carboniferous sandstone from many of the former local quarries in and around the city. Because of the large number of these quarries there is some degree of variability in the sandstone, but it has common characteristics which allow it to be defined as a distinct category. Typical examples of Type B2 sandstone from Glasgow buildings are A94 and B1 (Figure 9). A sample of sandstone from Giffnock quarries is shown for comparison in Figure 10

The sandstone has a very pale (whitish) colour when fresh, is quartz-rich with a small amount of feldspar and lithic grains, and has a generally uniform medium to fine grained texture. It contains variable proportions of iron oxide, carbonate and clay minerals (together typically ranging up to c.20 modal per cent). Where weathered, the carbonate is commonly altered and stained by mobilised secondary iron oxides, producing a strong orange-brown speckled appearance to the stone. At its most advanced (and sometimes where the stone has been chemically cleaned) surfaces show a variable overall orange-brown colour.

Examples of quarries which produced this sandstone type are listed below:

Avenuehead, Glasgow (some bedded)
Bishopbriggs quarries (including Huntershill), Glasgow
Blochairn, Glasgow
Germiston, Glasgow
Giffnock quarries, Glasgow
Hillhouse Muir, Glasgow
Monksredding, Kilwinning

The Giffnock and Bishopbriggs quarries were the principal sandstone quarries supplying the city in the late 19th century, and a number of quarries of different names operated in both localities. Together, these quarries are likely to have supplied a large proportion of the sandstone for Glasgow.

Figure 9a. Sample of typical Type B2 showing typical characteristics, very similar to stone from Giffnock quarries. (A56 Queens Park Church)

Figure 10. Sample of sandstone from one of the Giffnock quarries, typical of Type B2 sandstone with uniform texture and very pale ‘blonde’ colour with small specks caused by presence of small iron oxide grains.

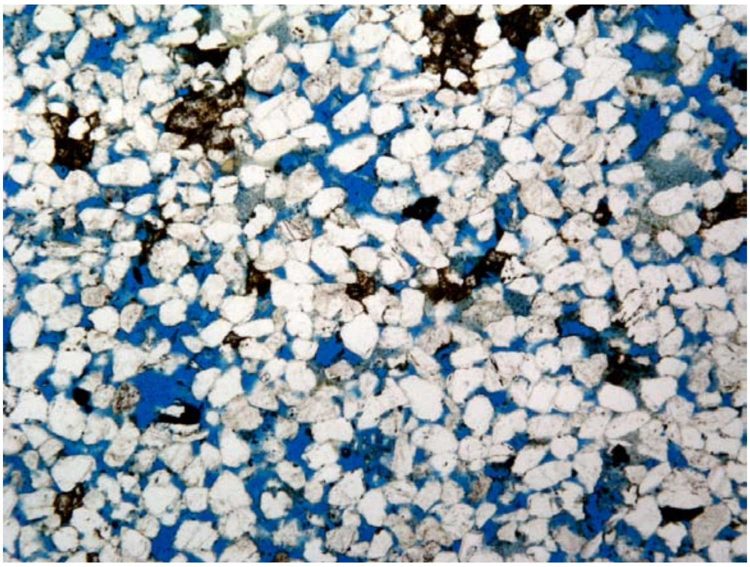


Figure 9b. Thin section image of typical Type B2 sandstone showing uniform well sorted grain distribution, with open porosity locally infilled by clay minerals, dark iron oxides and altered carbonates partially replaced by secondary iron oxides. Porosity highlighted by blue dye resin. Image is c.3 mm across. (A94 Springburn Nursery School)

(ii) Currently available matching stone

None of the original quarries in the Glasgow area are in operation and all the sandstone used for repairs has to be imported from further afield. A small number of currently operating quarries, mostly in Northumberland and northeast England supply stone with broadly similar characteristics (though see discussion below). Examples of currently available similar sandstones are Darney, Black Pasture, Scotch Buff and Blaxter, although these typically contain more iron oxide producing a stronger buff colour rather than a pale 'blonde'.

Type B2a

(i) Description

Some of the original local quarries produced a blonde sandstone showing greater variability in grainsize and composition, here referred to as Type B2a. It is typically medium to coarse grained and contains significant proportions of opaque iron oxide and clay minerals which partially infill the pore spaces. This sandstone has a slightly more overall buff colour, and a speckled appearance of darker grains within a pale groundmass. Where weathered, the iron oxide becomes increasingly orange in colour, resulting in a variable orange appearance to masonry blocks. Type B2a sandstones may or may not contain carbonate. Examples of Type B2a sandstone from Glasgow buildings are A83 and B35 (Figure 11).

Figure 11a. Type B2a stone showing typical blonde uniform texture but containing relatively common iron oxide and carbonate (note alteration of these minerals forming weathered surface on left-hand side). (B24 Glasgow University Main Building)

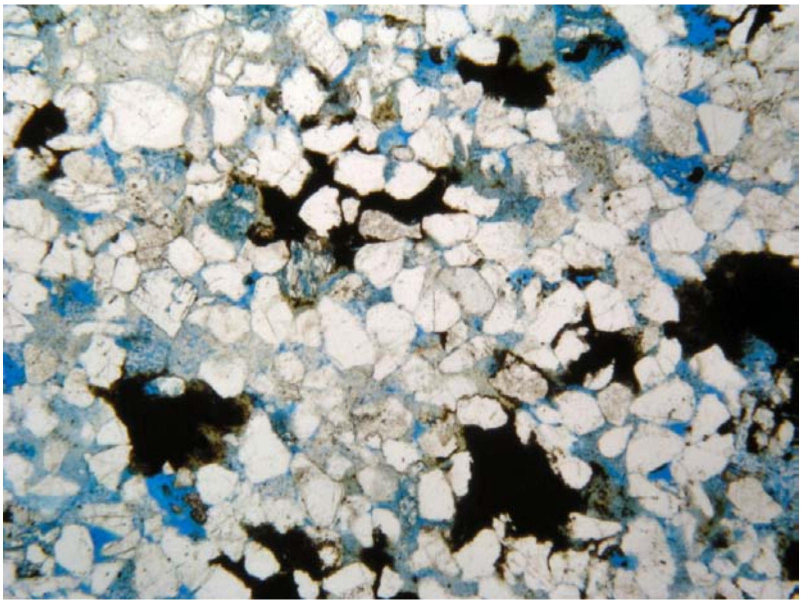


Figure 11b. Thin section image of Type B2a sandstone showing presence of relatively common iron oxide (black) and fine grained clay minerals (pale grey) partially infilling porosity. Porosity highlighted by blue dye resin. Image is c.3 mm across. (B35 Tramway Theatre)

Quarries in west-central Scotland and the Glasgow area which supplied stone of Type B2a for construction in Glasgow are:

Doghillock, Denny
Kirkburn, Cambuslang
Laverock Knowe, Airdrie
Muirhouse Farm, Glasgow
Plean, Falkirk
Polmont, Glasgow
Woodhall, Glasgow

(ii) Currently available matching stone
A number of current quarries supply sandstone with similar characteristics to Type B2a sandstone. Examples of these are Blaxters High Nick, Blaxter, Black Pasture, Dunhouse Buff, Stainton and Witton Fell. Some of the samples in this category show distinct similarities to north of England sandstones, and it possible that some of the buildings were originally constructed of stone from these quarries (e.g. A83 Hillhead High School built c.1930).

Type B3
(i) Description
A number of former quarries supplied blonde sandstone which has a variable grainsize (poorly sorted) and relatively impure mineral composition. Type B3 sandstones contain relatively more mica, clay and iron oxide and are characterised by their variable grainsize, resulting in a reduction in porosity. On a macroscopic scale they have a more 'dense' appearance compared to the Type 2 sandstones. Typical examples of Type 3 sandstone from Glasgow buildings are A12 and B36 (Figure 12).

Former quarries which supplied stone of this type are:
Auchenlea, Motherwell
Budhill, Shettleston
Chatelherault, Hamilton
Dullatur, Glasgow

(ii) Currently available matching stone
A number of currently active quarries supply stone with similar characteristics to Type B3, such as Blaxter, Blaxter High Nick, Black Pasture and Stainton. The more poorly sorted varieties with considerably less porosity are more similar to stone from quarries such as Witton Fell, Coarse Buff and Stanton Moor. The variable nature of this sandstone type means it is difficult to generalise in terms of selecting a replacement sandstone, and petrographic analysis is essential in each case.

Figure 12a. Type 3 sandstone showing variable grainsize with relatively common opaque white clay minerals and some orange colouration from iron oxides and carbonate. (A103 Pollockshields Primary)

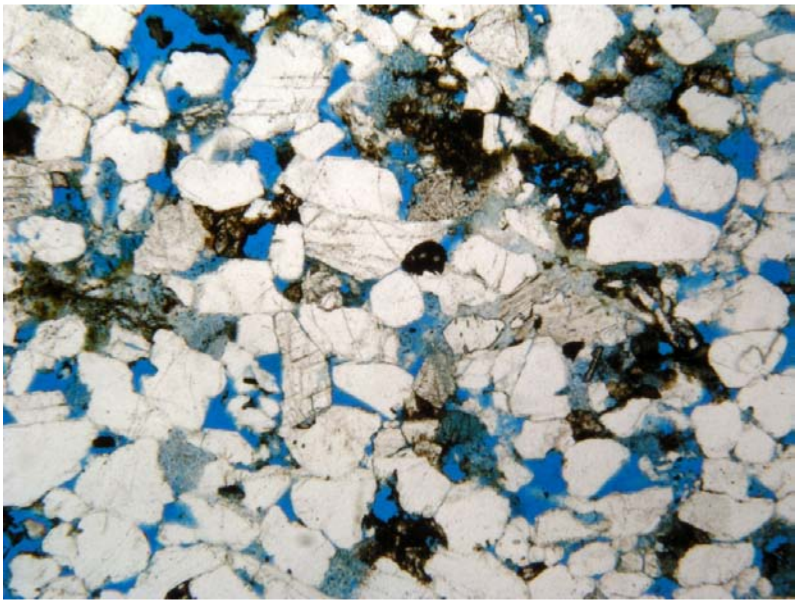


Figure 12b. Typical sandstone of Type B3 showing poorly sorted nature with variable grainsize and impure, variable composition with iron oxides, clay minerals and altered carbonate.
Porosity highlighted by blue dye resin. Image is c.3 mm across. (B36 Mansionhouse Drive)

Type B4

(i) Description

A particularly distinctive sandstone type used in Glasgow buildings is a thinly bedded ‘wispy’ sandstone characterised by dark laminations and ‘ripple’ laminae comprising dark iron oxide, carbonaceous matter and mica. The sandstone is generally uniformly fine grained, with an open pore structure. Some samples of this type are less laminated with a more uniform texture, but still have the characteristic fine grainsize and open pore structure. Typical examples of Type B4 sandstone from Glasgow buildings are A79 and B91 (Figure 13).

The original quarries which supplied this stone have not been identified. The stone has been used in early buildings immediately west of the city centre and in Gilmorehill, suggesting that the original quarries could have been local to these areas and are now built over.

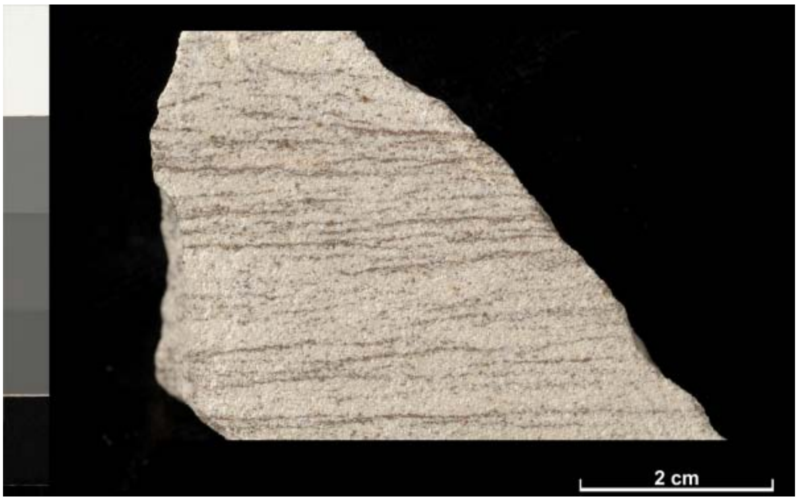


Figure 13a. Typical sample of Type B4 sandstone showing characteristic 'wispy' bedding lamination within a fine grained very pale groundmass. (B73 Old Govan Docks building)

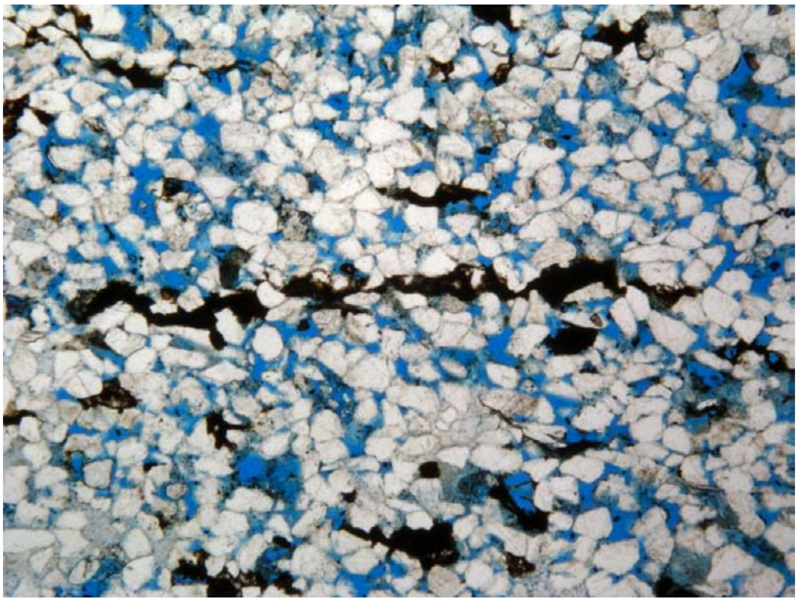


Figure 13b. Thin section image of Type B4 sandstone showing typical fine grained uniform nature with relatively high porosity, and elongate beds laminae of opaque iron oxides (black). Porosity highlighted by blue dye resin. Image is c.3 mm across.

(ii) Currently available matching stone

It is difficult to identify a currently available matching sandstone with similar characteristics to the Type B4 stone. A number of quarries produce stone with a similar fine grained open pore structure, such as Scotch Buff, Darney and Spynie. However, only Scotch buff contains dark bedding laminae, and it generally has a stronger overall buff colour than the original sandstone.

Type B5

(i) Description

Some of the building samples are a distinct coarse grained, sometimes 'gritty', poorly sorted sandstone with variable bedding. They are variably coloured, although typically pale. Most of these sandstones would have been a difficult stone to work as a building stone, and it is likely that they represent early local quarries which provided relatively small quantities of stone for an individual building or local area (e.g. the 1794 Castlemilk House stables B103, which is likely to have been supplied by a quarry within the then Castlemilk Estate). Typical examples of Type B5 sandstone from Glasgow buildings are A35 and B132. Figure 14

Figure 14a. Type B5 sandstone showing very coarse grained nature with open pore structure and common white powdery clay minerals. (B103 Castlemilk Stables)

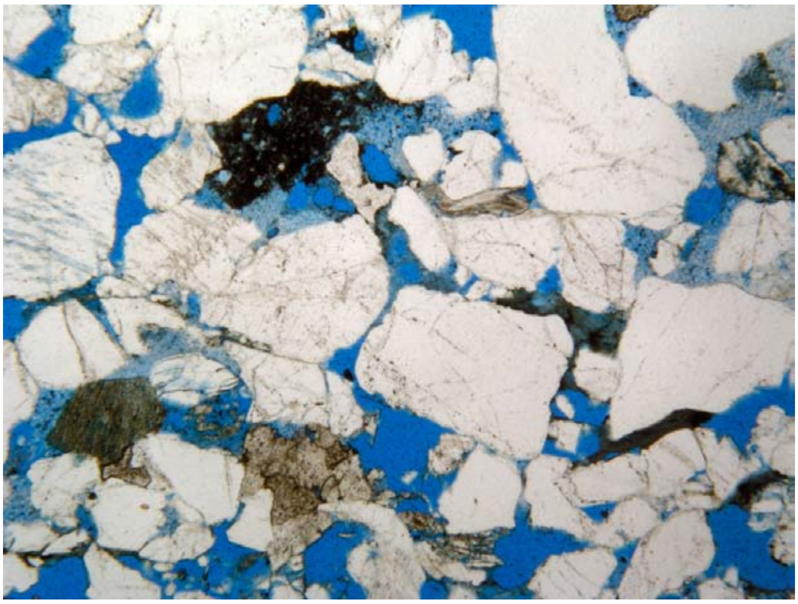


Figure 14b. Thin section image of Type B5 sandstone showing coarse grained nature with poorly sorted grainsize distribution and iron oxide (black) and carbonate and altered lithic grains (grey-brown colour). Porosity highlighted by blue dye resin. Image is c.3 mm across. (B132 Castle Street).

(ii) Currently available matching stone

A number of quarries in northern England currently supply stone with broadly similar characteristics to the Type B5 sandstone, such as Bearl, Catcastle, Mill Grit, Coarse Buff and Peak Moor. The variable nature of this sandstone type means it is difficult to generalise in terms of selecting a replacement sandstone, and petrographic analysis should be undertaken for specific examples.

3.4.2 Discussion and requirements for the supply of blonde sandstone

It is apparent that blonde sandstones with a wide variety of characteristics were used for the construction of buildings in Glasgow. This is not surprising given the long time period (several centuries) over which the city developed, and the large number of documented quarries which supplied building stone to the city (Table 5). Although most of the blonde sandstone used in Glasgow was obtained locally, this variable character means that some varieties are similar to sandstones from other parts of the United Kingdom, in particular Type B1 which is similar to Carboniferous sandstones from Stirlingshire and the Lothians. The gradation of characteristics seen in Types 2a, 3 and 5 shows similarities to some sandstones from the Carboniferous basins of Northumberland and Yorkshire.

Despite this variability, some of the characteristics of the original blonde sandstone appear to be unique to the specific composition and digenetic (geological) history of the local Carboniferous sandstones in the Glasgow basin, and are not easily ‘matched’ by any currently available sandstone produced in other parts of the United Kingdom. If the character and condition of Glasgow’s historic stone buildings is to be maintained, it is important that stone of similar characteristics to the original stone is used for repairs. The variety of blonde sandstone types present in Glasgow’s buildings means that careful stone matching involving characterisation of the original stone type should be carried out to identify the specific stone type used and identify the most appropriate currently available matching stone type.

Of the six types of blonde sandstone identified in this study, the most important (and abundant) is the uniform blonde Type B2 stone which supplied a large proportion of the surveyed buildings (Table 4). As mentioned previously, none of the original quarries which produced this sandstone are in production. A number of quarries currently operating in northeast England have been identified which produce stone of broadly similar composition, grainsize, texture and porosity characteristics. However, most of these sandstones contain more iron oxide producing a stronger buff colour than the original characteristic pale blonde stone. In addition, many of the currently available sandstones from northern England show stronger compaction and more variable grainsize, resulting in less porosity than the original sandstones. If repairs to buildings are to use a compatible sandstone type, then there is a clear need for production of a more similar sandstone which has characteristics closer to Type B2. The best way of ensuring a compatible stone would be to source material by opening (or reopening) a quarry in the Glasgow district. The opening of a single quarry may not be sufficient to satisfy the variability identified, but would go a long way to improve the similarity of replacement stone to the original masonry.

Type B4 sandstone also has a particularly distinctive character, typical of the local Carboniferous sandstone, which is difficult to ‘match’ to currently-available sandstone types. It is an unusual, very fine grained sandstone with a distinctive wispy bedding lamination and relatively high porosity. As with Type B2 stone, there are very few current quarries producing stone with similar characteristics, although a number of quarries in northeast England provide stone of similar grainsize and porosity characteristics. There is, therefore, an additional requirement for a renewed supply of this type of sandstone, although it is has been much less commonly used in the city compared to the Type B2 blonde sandstone (Table 4).

As noted above, types B2a, B3 and B5 each have more similarities to currently produced sandstones in other parts of the United Kingdom. In these cases it should be possible to obtain a reasonably similar matching stone from current quarries active in the UK, provided careful analysis of the original stone is undertaken. It should be pointed out that observations made during this study of recent stone repairs to Glasgow buildings suggest that in many cases there appears to be little consideration of compatibility of the stone types in the selection of replacement blonde sandstones. It is apparent that there is a need for improved decision-making in the selection of stone for repairs, and at least an increased awareness of the diversity of sandstone types available in the United Kingdom today. The use of inappropriate sandstone types for repairs to historic buildings has been shown to lead to increased decay in the remaining original masonry in the building (Hyslop 2004).

In summary, although no building sandstone quarries are currently operating in the Glasgow area, a number of the original stone types can be matched to currently active quarries in other parts of the UK. However, no current quarries are producing a stone with similar characteristics to the most commonly used blonde sandstone (identified here as Type B2). If Glasgow's buildings are to be repaired using appropriate stone, then a renewed source of such stone will be required. In addition, the Type B4 stone described above also is not represented by currently available sandstone types in the UK.

3.4.3 Analysis of red sandstone samples

The samples of red sandstone from buildings have been divided into four generalised categories based on their petrological characteristics. The purpose of the groupings is to allow stones of similar characteristics to be 'matched' to similar currently available stone types, and to identify where particular stone types are not currently available. The main characteristics of the four red sandstone categories are summarised below, together with likely original quarry sources and currently available matching stone types:

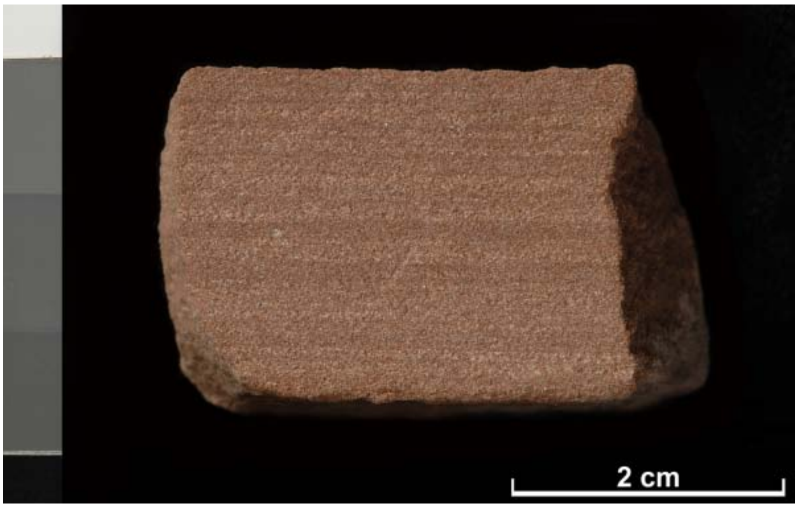


Figure 15a. Sample of Type R1 sandstone showing typical fine grained texture and relatively dark colour. This example has thin bedding laminae, although it can also have a uniform texture. (A60 Jordanhill Parish Church)

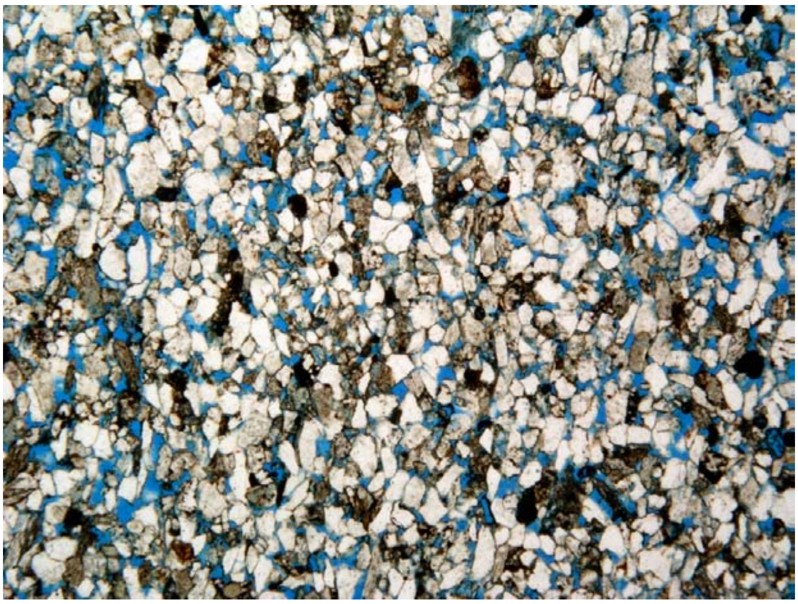


Figure 15b. Thin section image of Type R1 sandstone showing typical fine grained nature with relatively common darker iron oxide and lithic grains. Porosity highlighted by blue dye resin. Bedding is aligned vertical Image is c.3 mm across. (A61 Carmyle Parish Church).

Type R1

Type R1 is generally fine grained with a relatively dull reddish colour. It commonly shows parallel laminated bedding with relatively common and strongly aligned mica, although it can be more uniform. Some varieties contain a higher content of more iron oxide and mica. It typically contains up to c.10% altered lithic grains. An example of Type R1 sandstone is shown in Figure 15. Examples of currently available sandstone of this type are Corsehill, Cove Red and St Bees.

Type R2

Type R2 is a medium grained well-sorted sandstone with a high open porosity. It typically displays planer bedding, and some varieties show thin parallel bedding laminae. Typical Type R2 sandstone is shown in Figure 16. The characteristics match stone from Gatelawbridge and Corncockle quarries. It is understood that Gatelawbridge quarry is no longer in operation. The closest currently available supplies of this stone appear to be varieties of Corncockle (finer variety), Corsehill (coarser variety) and Locharbriggs. Original stone from Gatelawbridge quarry is typically medium grained compared to Corncockle which is medium to coarse grained.

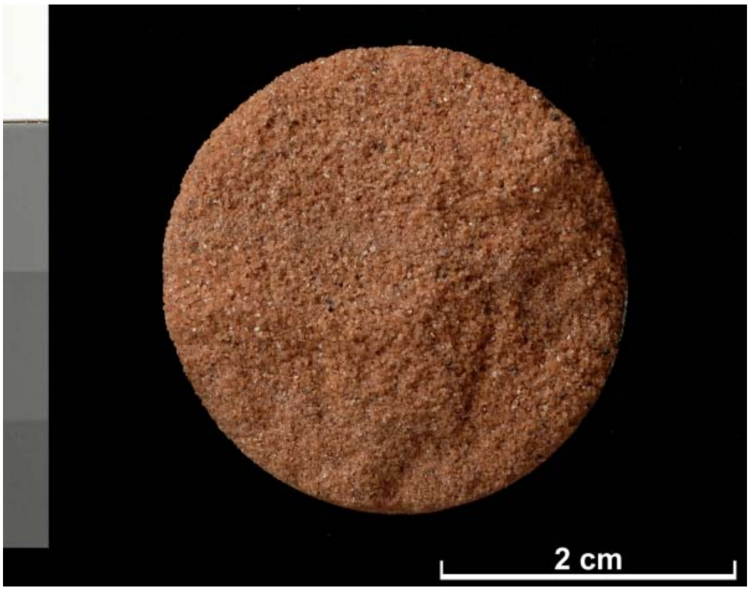


Figure 16a. Sample of Type R2 sandstone, showing typical coarse grained open texture with faint bedding planes of finer grainsize. White feldspar grains are visible and occasional black iron oxide and/or carbonaceous grains. (B94 Queen’s Cross Church)

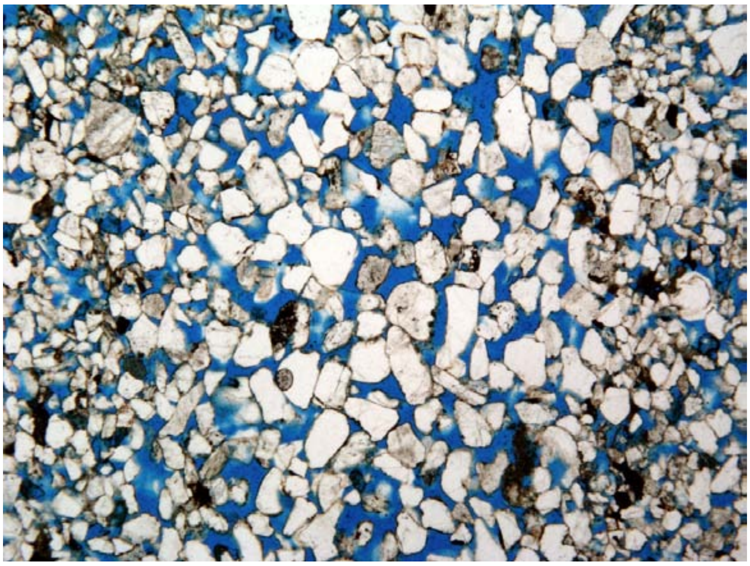


Figure 16b. Thin section image of Type R2 sandstone showing parallel bedded laminae (aligned vertical in image), with variable grainsize in different beds.
Porosity highlighted by blue dye resin. Image is c.3 mm across. (A75 Holy Cross Primary School)

Type R3

Type R3 is typified by a strongly bedded or laminated texture, commonly showing a bimodal grainsize population with large well rounded coarse grained quartz grains in thicker beds and thinner beds dominated by fine grained beds. It is dominated by quartz with minor feldspar and less lithic grains, generally with a very high open porosity. Typical Type R3 sandstone is shown in Figure 17. This type probably represents the original Ballochmyle (Ayrshire) stone, which is no longer quarried. It also has similar characteristics to Locharbriggs. The closest currently available sandstone for this sandstone type are Corncockle and Locharbriggs.

Figure 17a. Sample of Type R3 sandstone showing typical coarse grained open texture with thin parallel beds of finer grainsize. (A88 Elmvale Primary)

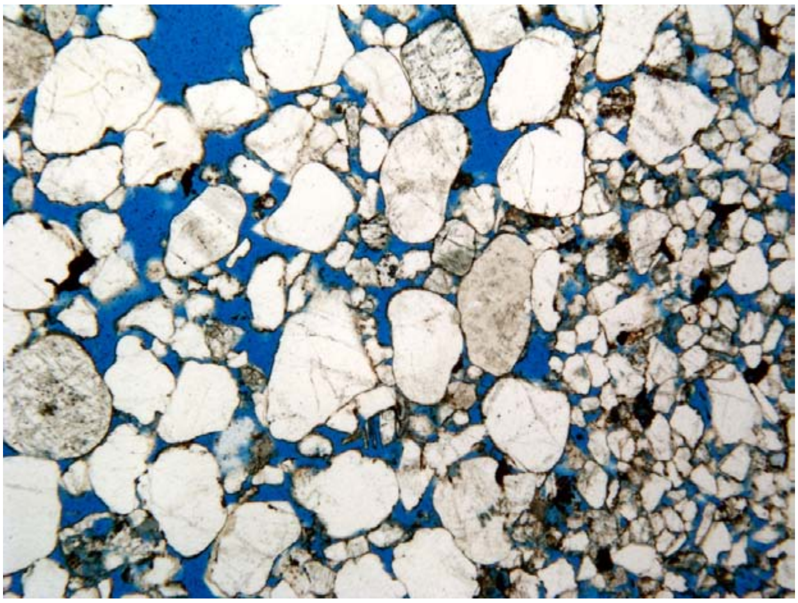


Figure 17b. Typical Type R3 sandstone with bimodal grainsize of large rounded grains in some beds and finer grains in thinner laminae (aligned vertical in image). Porosity highlighted by blue dye resin. Image is c.3 mm across. (A29 St Agnes RC Church)

Type R4

Type R4 is a broader category for red sandstone of more varied character. It probably represents stone from a number of quarries in the Glasgow area, including sandstones of Carboniferous and Devonian age (i.e. not 'true' red sandstones in the sense of Permian and Triassic sandstones of Ayrshire and Borders). In some cases the stone shows similarities to samples from historic quarries at Dalreoch, Bellshill and

Bredisholm, all of which are no longer in operation. The stone is generally variable and poorly sorted, often coarse grained and typically pale (pinkish to lilac) in colour. Carbonate may be present, and samples can be relatively mica and clay-rich. Typical Type R4 sandstone is shown in Figure 18.

Currently available matching stone comes from a variety of quarries throughout the UK, including Cloudside gritstone, Brownieside, Wattscliffe Lilac, Red Hollington, Doddington, Stoneraise and Lazonby. Stone from historic Dalreoch quarry is particularly variable and some is macroscopically more similar to Corsehill and Locharbriggs quarries. Some Type 4 sandstones samples from buildings do not show similarities to any of the currently available quarries above. Because of the variability of Type R4 sandstone it is recommended that a petrographic analysis is undertaken in order to select a matching currently-available stone type.

Figure 18a. Sample of Type R4 sandstone showing unusual greyish-lilac colour produced by common fine grained iron oxide grains throughout. The stone is a much stronger red colour when weathered. (B9 New Cathcart Church)

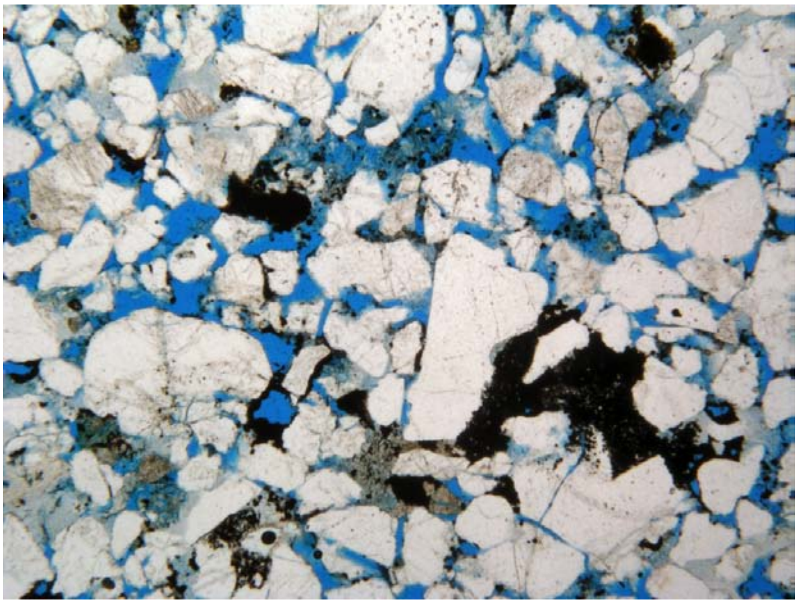


Figure 18b. Type R4 sandstone showing typically variable grainsize with angular grains and impure composition with iron oxides (black). Porosity highlighted by blue dye resin. Image is c.3 mm across. (A27 Saltoun Street)

3.4.4 Discussion and requirements for the supply of red sandstone

The situation for the supply of red sandstone is slightly improved compared to that for blonde stone, since several of the original quarries that supplied stone for construction in the late 19th and early 20th centuries (mainly in Dumfriesshire) are currently in production. However, some quarries which are known to have been major suppliers of stone to Glasgow, such as Ballochmyle quarry (at Mauchline in Ayrshire), are no longer in production. In terms of obtaining matching stone types for the categories identified above, most of the stone requirements can probably be met from the currently active quarries at Locharbriggs, Corncockle, Corsehill and to a lesser extent St Bees and Cove. Type R4 stone may be obtained from a larger number of other quarries, as detailed above.

Despite the current availability of compatible red sandstone, it should be noted that the most suitable stone for Types R2 and R3 above is supplied by only 3 quarries (Locharbriggs, Corncockle and Corsehill). The closure of any one of these quarries would present the loss of a unique matching stone type which would make it impossible to obtain compatible stone for the repair of some buildings. Likewise, if the demand for stone increases in the future (either for repairs or new build) the very limited number of quarries may not be able to satisfy demand, again resulting in problems through lack of compatible stone or potentially inappropriate stone types being used. For example, Corncockle stone is distinct from Locharbriggs and Corsehill in having a more orange colour and particular texture and porosity. If Corncockle stone became unavailable, neither Locharbriggs or Corsehill is likely to be able to supply a petrographically compatible replacement sandstone.

In summary, although there are current quarries which are able to supply the present demand for appropriate matching red sandstone, these are so few that the closure of any quarry is likely to create a shortage of appropriate replacement stone for repairs.

3.4.5 Use of the data and issues of stone matching

It is recommended that the stone matching results from this study described in this section should not be used for the selection of stone for specific repairs projects to buildings without further consideration. Firstly, the sample collected may not be representative of all the stone types present in a particular building. Many buildings contain stone from different quarry sources for different constructional or decorative elements, as well as different phases of construction and repairs. Secondly, the stone matches identified in this report represent current knowledge of the availability of stone types. Future changes in stone supply may mean that more appropriate (i.e. better matching) stone types may become available. It should be emphasised that BS 7913 1998 (Guide to the principles of the conservation of historic buildings) and BS 8221, 2000 (Code of practice for cleaning and surface repair of buildings) state that stone matching for repairs projects should be undertaken by a stone specialist using petrographic analysis.

4. STONE AND MASON SKILLS REQUIREMENTS

4.1 BUILDINGS COUNT

4.1.1 Development of Methodology

An estimate of the number of stone buildings within the City of Glasgow is required in order to extrapolate the stone quantities and stonemason time requirements calculated for the surveyed facades to the entire stone-built building stock of the city. This is a difficult task for which there is no known precedent. Enquiries with Glasgow City Council, Historic Scotland and the Mitchell Library failed to identify any previous studies of this type for the city. It was therefore necessary to develop a strategy which would allow a practical approach within the time and budget constraints of the project whilst providing as accurate a result as possible.

The selected method involved operating on a number of different scales and levels of detail. The initial approach was to eliminate the 'non-stone' areas of the city using published maps to identify parts of the city that were developed after the Second World War. It is assumed that buildings constructed after this time were not built using stone as a load-bearing material. This enabled the removal of large areas of housing schemes particularly in the outer parts of the city, for example Castlemilk, Nitshill, Drumchapel, Summerston, Easterhouse and others. Despite this, a small number of stone buildings exist in some of these areas, for example some contemporary churches were constructed in stone. Additionally some older pre-existing stone buildings survive in these areas, such as Castlemilk Stables in Castlemilk and Blairtummock House in Easterhouse (both significant listed buildings). It was therefore necessary to undertake more detailed examination of historic maps and 'drive-through' surveys of some of these areas to in order to quantify these additional buildings (see details breakdown of areas below).

Older parts of the city which are dominated by stone buildings can be identified using historic maps. However, differentiation of stone from non-stone buildings proved more problematic than first assumed. Many parts of Glasgow have undergone redevelopment involving demolition of stone housing and construction of new (largely brick and cement block) buildings. In some areas this has involved wholesale replacement where the map 'footprint' or street pattern of the new buildings is distinctive enough to allow them to be differentiated from original stone buildings (e.g. Gorbals). However in most areas redevelopment has been more 'piecemeal' with new buildings commonly using the same 'footprint' or street pattern as the demolished stone buildings. This is particularly true of 'infill' development which is widespread throughout the city. It is therefore impossible to distinguish such properties using only maps. Initial attempts to attribute different areas into groups with different proportions of stone buildings to non-stone proved extremely difficult, and it quickly became clear that such an approach would have led to inaccurate results.

Attempts to categorise specific areas into known or 'assumed' proportions of stone to non-stone buildings based on map analysis also led to difficulties. For example, industrial and commercial parts of the city can generally be easily identified on maps because of distinctive street and building patterns. Drive-through checks of industrial areas such as Tradeston-Kinning Park and Bridgeton showed that although many industrial or commercial premises have been rebuilt using materials other than stone, many earlier stone buildings survive which are not obvious on maps.

The methodology developed for the buildings count was therefore a combination of initial map examination which enabled delineation of different areas into generalised categories of 'non-stone', 'mixed/unknown', and 'stone-dominant'. Verification of both 'non-stone' and 'stone-dominant' areas was required in the form of drive-through surveys, for the reasons described above. The areas identified as 'mixed/unknown' were printed out on large-format A1 and A2 sheets from the current issue of Ordnance Survey Master Map Series at a scale of 1:4000, showing individual buildings and property boundaries. A total of 27 map sheets were produced. Each of these maps was then marked-up to highlight stone and non-stone buildings using a combination of examination of historical maps and drive-through surveys.

The counting of stone buildings in Conservation Areas was undertaken by Glasgow City Council in consultation with Mr Dennis Urquhart, using 1:1250 scale maps to mark the locations of stone buildings. A system for estimating facade numbers was also developed as part of the counting for Conservation Areas, and this was used for the remaining 26 maps to provide data for the remainder of the city. The counting system used to produce the numbers of stone buildings/facades developed by Mr Dennis Urquhart for the Conservation Areas is given below:

- Large detached buildings (such as churches, schools etc.) are counted as 1, even where there will be four or more facades.
- Buildings which are essentially free standing, such as a church, but have another building attached such as a church hall, are counted as 2.
- Detached houses or mansion –only the main facade is counted.
- Terraces and tenements –each main facade to a street that is contained within the property boundary lines on the OS 1:1250 Master Map plan counts as 1.
- Tenements and city blocks – a corner tenement or block with facades on two streets (i.e. on a corner) counts as 2.
- Generally the numbers do not represent the number of individual properties, for example a faced in a terrace or tenement will normally cover more than one property.
- It is noted likely that not all of the non-stone buildings have been correctly identified in the Conservation Areas, but that the number of stone facades calculated is likely to be a reasonable approximation of the actual number.

The counting method described above is likely to underestimate the number of facades present for many buildings. For example a mid-terrace or tenement block is likely to have two stone faces (front and rear), and detached buildings will have more. However in many cases the rear and side elevations of stone buildings were constructed from different (perhaps lower quality) stone, or in some cases brick.

4.1.2 Building Count Results

<u>Conservation Areas</u>

The results of the calculations of stone facades for each of the 21 Conservation Areas are given below:

Conservation Area	Stone facades
Park	577
Glasgow West	2579
East Pollockshields	477
West Pollockshields	664
Dennistoun	162
Crosshill	304
Drumbreck	204
Snuff Mill	50
Strathbungo	240
Walmer Crescent	28
St Vincent Crescent	81
Central	1404
Carmunnock	72
Victoria Park	170
Newlands	718
Woodland	352
Scotstoun	631
Millbrae	54
Pollock Park	2
Hazelwood	1
Parkhead Cross	76

Total = 8846

Stone buildings outside Conservation Areas

Counting of stone facades for the 27 sheet areas outside the Conservation Areas is given below (using the same calculation method as for the Conservation Areas):

Sheet Area	Stone facades
Broomhill	1497
Kelvin Hall	833
Ruchill/Possilpark	350
Springburn	244
Govan/Shieldhall	665
Ibrox	579
Gorbals	182
Govanhill	991
Lambhill	159
Stobhill	69
Kelvindale/Temple	891
Maryhill/Woodside	378
Shawlands	2208
Kings Park	507
Newlands	1242
City Centre	412
Riddrie/Carntyne	820
Shettleston	849
Carmyle	303

Mount Vernon/Baillieston	359
Bridgeton/Dalmarnock	213
Carmunnock	42
Craigton/Mosspark	358
Hillington/Cardonald	449
Scotstoun	568
Yoker/Drumchapel	211
Dumbreck/North Pollockshields	38

Total = 15417

Additional stone buildings

In addition to the main concentrations of stone buildings outlined above, there are a number of additional stone buildings included in the buildings count.

(i) Stone buildings in 'Modern' suburbs

The 'modern' (generally post-war) suburbs were excluded from the buildings count because the majority of the buildings are constructed from brick and other manufactured materials. However these areas do contain a limited number of traditionally-built stone buildings (e.g. churches, schools, original stone houses etc.). These suburbs were divided into nine areas, as listed below, six of which were investigated in detail:

Area	Stone facades
Drumchapel	not counted
Knightswood	4
Robroyston, Hogganfield, Millerston	10
Garthamlock/Easterhouse	not counted
Castlemilk	1
Carnwadric, Jenny Lind, Arden	1
South Nitshill, Priesthill, Houshillwood	4
Crookston, Pollock	3
Penilee, North Hillington	not counted

Total number of stone buildings for the 6 counted areas = 23, producing an average of 3.8 buildings per area, generating a **total = c.35 stone facades**.

(ii) Rural areas

The number of stone buildings in rural areas within the city boundaries (mostly farms and cottages) was also estimated. The relatively large rural area fringing Easterhouse, including Swinton and Gartloch Hospital and cottages produced a **total of 63 stone facades**. In addition 17 farms were identified in other areas of the city outskirts. Assuming an average of 3 stone buildings per farm, this produces a **total = 51 stone facades.**

(iii) Other stone structures

A number of other stone structures were not included in the buildings count because of the difficulty in obtaining accurate numbers. These include stone bridges and structures related to the railway and canal systems, including the large numbers of railway arches used as commercial properties. Stone monuments (including gravestones) were also not included in the count. Note that these structures may still be considered as part of the stone heritage of Glasgow, and their future repair and maintenance needs are worthy of consideration.

Total number of stone facades

In conclusion, the total number of stone facades identified in the City of Glasgow, using the counting methods described above, is **24,349**.

4.2 CALCULATION OF STONE QUANTITIES AND MASON TIME

4.2.1 Methodology

The marked-up digital facade images showing areas of decayed and damaged stone were produced as a series of colour printouts at A3 size for calculation of stone volumes required for repair and 'mason days' required to undertake the repairs.

The calculations were made for all stone marked as requiring immediate replacement (solid red areas) and replacement within 20 years (solid yellow areas) on the survey images. The results of these calculations are presented individually for each building in the building survey sheets in Appendix 1, and are compiled in Tables 6 and 7.

The square metre area of stone required was calculated by using the computed surface areas of decayed stone provided on the digital facade images, and by direct measurement of the scaled areas which were marked on each building image. The volume of stone required for each building is a combination of a series of separate calculations for different architectural elements of the facade. For example, carved and moulded details such as cornices and scroll brackets are calculated differently from ashlar walling block as they require different depth for carving and fixing.

The volume of stone calculated for each building is presented as tonnes of random block, as supplied by the quarry. This allows for 50% loss of stone from the supplied quarried block in the production of the finished masonry element (i.e. 100T of finished masonry requires 200T of quarried block). Such loss is standard practice in calculating stone requirements.

The calculation of mason time for the stone repairs required within 20 years is given in days for Banker Mason, Site Mason and Stone Carver. In most cases a banker mason is capable of undertaking almost all the moulded and carved work required, and a specialist carver is typically employed for individual sculptural details such as statues. The site (or fixer) mason deals with the dressed stone prepared by the banker mason. The calculation of site mason time includes time for repointing of mortar joints where required.

For 14 of the surveyed facades a correction factor has been applied to the results in Tables 6 and 7. This is used where the surveyed area did not cover the entire facade of a building, for example in unusually large buildings such as Scotland Street School (A99) where only half of one entire facade was surveyed. The calculated stone volume and mason day requirements are therefore multiplied (in this case by a factor of 2) in order to produce corrected figures for the entire facade. This approach was also taken in some buildings where part of the facade was not accessible or possible to photograph. In Tables 6 and 7 the correction factor is shown in the building name column in parenthesis e.g. (x2), and the corrected stone tonnes and mason days figures (i.e. those used for the final totals below) are also shown in parenthesis.

4.2.2. Total stone quantities and mason time requirements

The total number of facades surveyed (combined 'A' and 'B' lists) is 234. Addition of the stone quantity and mason time requirements from Tables 6 and 7 gives total amounts of:

Stone *tonnes*	3738.52
Banker mason *days*	5084
Site mason *days*	8906.5
Carver *days*	580

If these totals are extrapolated to the estimated population of stone buildings in the City of Glasgow from the buildings count described in section 4.1.2 (i.e. 24,349 stone facades) then the total stone volume and mason time required for the repairs over the next 20 years for the entire city is:

Stone *tonnes*	389,014
Banker mason *days*	529,018
Site mason *days*	926,771
Carver *days*	60,352

In order to examine the data in more detail the calculations can be performed separately for the 'A' and 'B' survey lists. If the total stone and mason requirements for the whole city are calculated on the basis of the 'A' list alone (112 facades) and then the 'B' list alone (122 facades), then the extrapolated totals are:

	using 'A' list	using 'B' list
Stone *tonnes*	401, 852	277,267
Banker mason *days*	515, 894	541,067
Site mason *days*	1, 020049	841,138
Carver *days*	9348	107,176

The differences between these two estimates is considered to depend on differences in the two lists of surveyed facades. For further comparison, the average amounts required *per facade* were calculated for both lists:

	Average 'A' list	Average 'B' list
Stone *tonnes*	16.5	11.39
Banker mason *days*	21.19	22.22
Site mason *days*	41.9	34.55
Carver *days*	0.38	4.4

These calculations show that there are differences in the average requirements for stone quantities and site mason time between the two lists, with the ‘A’ facades requiring significantly more than the ‘B’ facades. This is likely to be caused by the dominance of churches and schools buildings in the ‘A’ list, compared to the more diverse population of building types in the ‘B’ list (as discussed in section 2.1). The relatively large size of churches and schools is likely to increase the total requirements for these buildings, as well as the more complex nature of the stonework on church buildings in particular, with more intricate and moulded details requiring both increased volumes of stone and more mason time.

The increased requirement for average carver days for the ‘B’ facades is an artefact of the data caused by the inclusion of monuments in the ‘B’ list, which are absent from the ‘A’ list.

Differences in requirements for facades constructed from red and blonde sandstone can be seen by further examination of the data. The average stone quantity and mason time requirements for all the surveyed red sandstone facades can be calculated by combining the data for red sandstone buildings from the ‘A’ list (44 facades) with those from the ‘B’ list (39 facades). The average requirements for a red sandstone facade is therefore:

	Average red sandstone facade
Stone *tonnes*	11.66
Banker mason *days*	17.53
Site mason *days*	30.82
Carver *days*	0

The same calculation for blonde sandstone using 61 facades from the ‘A’ list and 73 facades from the ‘B’ list, gives an average requirement for a blonde sandstone facade of:

	Average blonde sandstone facade
Stone *tonnes*	20.11
Banker mason *days*	26.6
Site mason *days*	45.99
Carver *days*	3.77

There is clearly a significant difference between these two sets of results, indicating that the surveyed blonde sandstone facades require considerably more stone repairs than those constructed of red sandstone. The figures can be explained in several ways. Firstly, the average age of red sandstone buildings is likely to be younger than that of blonde sandstone buildings as red sandstone was mainly used after c.1885, whilst blonde sandstone was the principal stone used for all earlier buildings in the city. Secondly, observations of stone decay during the facades surveys indicate that blonde sandstone is more prone to stone decay, due to the presence of carbonate, iron oxide and clay minerals leading to scaling of the outer surface and accelerated erosion of the weakened subsurface zone (see section 2.3.2, and Bluck and Porter 1991).

The data can be used to provide an estimate of the quantities of red and blonde sandstone required for future repairs. As discussed earlier the ‘A’ and ‘B’ lists have different proportions of red sandstone to blonde sandstone (‘A’ list is 54.5% blonde and 39% red sandstone; ‘B’ list is 60% blonde and 32% red sandstone). As discussed in section 2.3.1 the ‘B’ list probably represents a more accurate estimation of the proportion of red to blonde sandstone for the city.

Therefore, using the proportions of 60% blonde and 32% red sandstone, it is possible to calculate the total requirements of the volumes of the two different sandstone types for the next twenty years. Using a value of 32% (i.e. 7,792) red sandstone facades in the city the requirements are:

Red sandstone *tonnes* 90,855

Using a figure of 60% of the facades in the city are blonde sandstone (i.e. 14,609 facades) then the requirements are:

Blonde sandstone *tonnes* 293, 787

This calculation assumes that 8% (i.e. 1,948) facades are constructed of other materials (includes mixed stone, other stone types such as granite and limestone, and mixed brick and stone).

5. SUMMARY AND CONCLUSIONS

The objective of this study is the provision of data for the preparation of a report by the Scottish Stone Liaison Group for Scottish Enterprise Glasgow as part of the SEG Construction Skills Action Plan for Glasgow. The facades of 234 stone buildings and monuments were surveyed to determine the condition of the stone in order to calculate the quantities of replacement stone needed and the masonry skills levels and time required for repairs over the next 20 years. In addition 120 samples of sandstone were extracted from surveyed buildings in order to characterise the variety and type of sandstone used for the construction of Glasgow's traditional stone buildings.

A methodology was developed for the facade surveys using digital cameras, with photographs taken from street level compiled to form a single image for each facade, corrected for distortion and perspective. Each image was georectified to a known measured area on the building to allow areas of decayed stone to be automatically calculated. A series of stone decay categories was devised using published data from recognised experts, adapted to suit the requirements of the project and the specific stone types and problems relevant to Glasgow buildings. Areas of stone decay identified during the field survey were marked digitally onto the facade images using a series of colour codes to indicate the urgency of stone repairs and maintenance needs. The marked-up digital images showing the areas requiring stone repair were passed to an external consultant for calculation of the amount of stone required and the masonry skill levels and time required for the repairs.

The surveyed buildings were selected from two lists, an 'A' buildings list of Listed Buildings prepared by the Scottish Stone Liaison Group, and a 'B' buildings list carefully chosen as a representative sample of the stone built heritage of Glasgow. The surveyed facades covered a range of building types including churches, schools, residential properties (e.g. tenement, terraced house, detached villa etc.), public buildings (e.g. library, swimming baths, hospital etc), commercial properties, monuments and industrial buildings (including public utilities and agricultural buildings). Buildings were selected to represent a range of criteria including facade orientation, geographical areas of the city, stone type, age and a number of other factors.

Observations of stone decay on the surveyed facades indicate that environmental and anthropogenic factors are important in determining the amount and type of stone decay. A major source of decay is likely to have been former air pollution which in many cases has been exacerbated by the presence of cement-based repairs ('plastic repairs') which have trapped or focussed moisture in the stone, leading to accelerated decay. In a number of buildings, stone cleaning has resulted in the loss of the stable outer surface of the stone exposing a weakened underlying zone which is more prone to erosion. Discolouration of blonde sandstone resulting from chemical stone cleaning is commonly observed, with the normally uniform pale colour becoming a variable orange and brown colour or bleached to a dull grey.

Detachment of the outer layers of the stone (scaling) is more pronounced in blonde sandstone than red sandstone. This is likely to be the result of the presence of carbonate, iron oxides and clay minerals and a more restricted internal pore structure in the blonde sandstone. Red sandstone generally has a more siliceous composition and a relatively open pore structure making it less susceptible to this decay mechanism. It is important to note that red sandstone was used in the city only from the late 19th century, and that many of the blonde sandstone buildings are older and will therefore show more stone decay for this reason.

Damage to stone masonry due to water penetration is a significant cause of stone decay. In many cases this could be avoided if appropriate maintenance was carried out, particularly in relation to rainwater protection (e.g. gutters and downpipes) and pointing of masonry joints using an appropriate mortar.

The samples of stone from buildings were subjected to petrographic analysis to determine the main varieties of sandstone used for the construction of traditional stone buildings in Glasgow. Six categories of blonde sandstone and four of red sandstone have been identified using macroscopic and microscopic criteria. The blonde sandstones range from uniform, highly siliceous sandstone to poorly sorted ‘impure’ sandstone containing clay minerals, carbonate and iron oxide, as well as bedded sandstone characterised by dark laminations. They represent Carboniferous sandstones, extracted mostly from quarries in the Glasgow area and adjacent parts of the Scottish Central Belt. The four categories of red sandstone also show a range of properties including variable grainsize, colour and porosity characteristics. They mostly represent sandstone of Triassic and Permian age imported into Glasgow from Ayrshire and Dumfriesshire. One variety of red sandstone represents ‘impure’ Carboniferous sandstone from the Glasgow area.

None of the original local blonde sandstone quarries that supplied stone to Glasgow are currently operating, and the present supply of stone for repairs is dominated by Carboniferous sandstone from northern England. Whilst some of these have similar characteristics to the blonde sandstone categories, a number of distinctive varieties of the local sandstone cannot be ‘matched’ to the currently available sandstone. If the built heritage of Glasgow is to be maintained using appropriate replacement sandstone, both in terms of appearance and performance, then there is a need for a renewed supply of blonde sandstone with these characteristics. Several of the original red sandstone quarries that supplied stone to Glasgow are still operating, and it is possible to obtain stone which matches most of the characteristics of the different red sandstones observed in the buildings. However, these quarries are so few that the loss of any one would put at risk the supply of appropriate red sandstone for repairs for the city. Many of the replacement stone types previously used for repairs in the city are not the most appropriate stones for repairs, and improved decision making is required in the future selection of stone if further damage to the stone heritage is to be avoided.

The stone volumes and mason time requirements for each surveyed façade have been calculated as stone tonnes, banker mason days, site mason days and stone carver days. In order to obtain figures for the entire city an estimate was made of the number of stone building facades in Glasgow, using a combination of detailed examination of historic and current maps and street surveys of selected areas. The total number of stone facades calculated is 24,349. Extrapolation of the requirements from the 234 surveyed facades to the total number of stone facades in Glasgow gives an estimate of approximately 389,000 tonnes of stone, 529,000 banker mason days 927,000 site mason days and 60,000 stone carver days, for the repair needs over the next 20 years.

Analysis of the data shows that blonde sandstone facades require significantly more repairs than red sandstone, requiring on average 66% additional stone and c.45% more total mason's time. Using an estimate of 60% blonde sandstone and 32% red sandstone for the proportion of red sandstone to blonde sandstone in the city as a whole, the estimated quantity of red sandstone required for repairs in the next 20 years is approximately 91,000 tonnes, whilst blonde sandstone is 294,000 tonnes. It should be noted that the above figures relate to the calculated needs based on the survey criteria and methodology outlined in this report. They do not necessarily indicate the amount of repairs that will actually be carried out as this will depend on factors beyond the scope of this report.

Other points arising from the survey work are given as a series of bullet points below:

- 'Plastic' cement repairs are observed in c.56% of the surveyed facades, compared to c.18% which show evidence of previous stone repairs. In many cases plastic repairs are reaching the end of their life and showing signs of failure. In some cases the presence of plastic repairs has resulted in enhanced damage to the adjacent remaining stone masonry. These observations suggest that plastic repairs should be considered as a short-term solution only, and in economic terms it would be more appropriate to undertake high quality stone repairs which are compatible with the original masonry and will last in the longer term. Approximately 14% of surveyed facades have undergone repointing using inappropriate cement based mortars which appear to be causing damage to the stonework.

- Approximately 34% of the surveyed facades show evidence of water penetration to the stone masonry, and a similar number require repointing of mortar joints in order to prevent water ingress. 31% of the surveyed buildings require urgent maintenance if damage to stone masonry is to be avoided. In addition c.23% of buildings show damage to stone masonry due to the presence of salts, due either to saturation of stone by water or from the use of winter de-icing salts to base courses and entranceways.

- Many surveyed tenement properties show evidence of previous comprehensive repairs schemes (many undertaken during the 1980/90's). These works commonly involved major refurbishment (façade cleaning, re-roofing using concrete tiles, replacement of components such as windows and rainwater goods and structural repairs). Replacement of decayed and damaged stone is generally minimal and most masonry repairs are cement patch 'plastic' repairs. Many of the refurbished properties appear to have undergone little or no subsequent maintenance and in many cases rainwater goods such as gutters and downpipes are now blocked or damaged, leading to water penetration to the walls and saturation of the stone. Unless maintenance is carried out decay of the stone masonry is likely to occur.

- The survey has identified that school properties in particular show a lack of maintenance, commonly related to blocked or damaged rainwater goods, resulting in saturation and damage to stone masonry. In contrast, church buildings are generally better maintained.

- It is considered that poor building maintenance, in particular in relation to rainwater, is a significant cause of stone decay. The economic case needs to be made that prevention now will be a fraction of the cost of stone repairs in the future, resulting in considerable financial savings. It is suggested that city-wide schemes could be established such as the successful 'Monument Watch' scheme run in Holland, and awareness campaigns should be instigated for building owners and the public. The fact that 83% of the surveyed buildings are currently occupied or in use is encouraging in terms of pursuing the maintenance issue.

- Predictions of climate change suggest that rainfall levels may significantly increase in parts of Scotland over this century, placing more pressure on the stone built heritage and increasing the chances of damage to stone.

- Of the c.31% of surveyed facades which require maintenance it is possible to calculate the amount of additional stone repairs that would be needed if maintenance is not carried out. In general terms, if an additional 31% is added into the calculations, this indicates that an additional 122,000 tonnes or an £181 million will be required. Although generalised, these figures could be taken as an upper limit 'warning' that unless maintenance strategies are introduced the costs to the city could be up to a third greater.

- Given the present situation, it seems unlikely that 100% of the repairs identified in this survey will be carried out over the next 20 years. However, with the increasing recognition of the value of the built heritage and the increasing importance of tourism to Glasgow it is likely that the stone built heritage will become an issue of increasing importance. The large number of refurbishment schemes currently taking place in the city centre indicates that in the current economic climate there is a perceived value and confidence in Glasgow's stone buildings.

- The work undertaken both in this study and from previous research indicates the need for improved decision-making in the selection of stone for repairs. The use of inappropriate replacement stone types will ultimately lead to further damage and increase the need for more stone repairs. It is important that petrographic matching is undertaken prior to stone replacement in order to characterise the original stone type present and identify the most appropriate stone type for the repairs.

- The study has identified six types of blonde sandstone and four types of red sandstone which are required for future repairs. Not all the required stone can be obtained from the current quarry output in the UK, both in terms of volumes of stone and stone types. It will therefore be necessary to investigate the possibility of reopening historic quarry sources in order to supply this need.

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Additional sources consulted for information on buildings

The following sources were consulted for information on buildings (e.g. dates of construction, stone types etc.). Note whilst every effort has been undertaken to ensure that the details contained in this report are correct, we recognize that there may be errors or omissions in regards to information obtain from external sources (including published references above).

http://www.gbpt.org	Glasgow Building Preservation Trust
http://buildingsatrisk.org.uk	Buildings at Risk Register
http://www.glasgow.gov.uk	Glasgow City Council
	Parkhead Cross Conservation Area Appraisal
	Carmunnock Conservation Area Appraisal
	Scotstoun Conservation Area Appraisal
http://www.nts.org.uk	National Trust for Scotland
http://pmsa.cch.kcl.ac.uk	Public Monument and Sculpture Association
http://gdl.cdlr.strath.ac.uk/springburn	Springburn Virtual Museum

http://www.eastrenfrewshire.gov.uk	East Renfrewshire Council
http://www.hlf.org.uk	Heritage Lottery Fund
http://www.scran.ac.uk	Scran
http://www.hyndlandparishchurch.org	Hyndland Parish Church
http://www.wellingtonchurch.co.uk	Wellington Church
http://www.sacredheartbridgeton.20m.com	Sacred Heart Church, Bridgeton
http://www.cathcarttrinity.org.uk	Cathcart Trinity Church
http://www.tradeshallglasgow.co.uk	Trades Hall Glasgow
http://www.tramway.org	Tramway
http://www.jgsgb.co.uk	Jewish Genealogical Society of Great Britain
http://www.patersonsquarries.co.uk	Patersons Quarries
http://www.gedc.org.uk	Greater Easterhouse Development Company
http://www.stonecleaning.co.uk	Mackay Building Repair and Specialist Restoration
http://www.spartan-solutions.com	Spartan Solutions
http://www.eveningtimes.co.uk	Evening Times
http://www.scotsman.com	The Scotsman
http://www.theglasgowstory.com	The Glasgow Story
http://www.adoptabuilding.com	Adopt a Historic Building
http://www.greekthomson.com	
http://www.scotland-guide.co.uk	
http://www.glasgowsculpture.com	
http://www.eastglasgowhistory.com	
http://www.hiddenglasgow.com	
http://www.sunnygovan.com	
http://www.glasgowguide.com	

Table 1. List of surveyed buildings ('A' buildings)

LIST	*No*	*PROPERTY OR BUILDING*	*ADDRESS DETAILS*
A	**1**	176 DUKE STREET, KIRKHAVEN	
A	**2**	110-136 (EVEN) FLEMINGTON ST	BOARD OF MANAGEMENT OF NORTH GLASGOW COLLEGE
A	**3**	3 MORAY PLACE	
A	**4**	CRAIGIE HALL, 6 ROWAN RD, DRUMBECK	
A	**5**	WELLINGTON UNITED FREE CHURCH, 76 UNIVERSITY AVENUE	
A	**7**	'WOODBANK', 56 PARTICKHILL ROAD	
A	**8**	ST GEORGE'S TRON PARISH CHURCH, NELSON MANDELA PLACE	
A	**10**	TRADES HALL, 79-91 GLASSFORD STREET	
A	**11**	190 TRONGATE & 2-4 GLASSFORD ST	ROYAL BANK OF SCOTLAND LIMITED
A	**12**	PEARCE INSTITUTE, 840-860 GOVAN ROAD	
A	**13**	GLASGOW SCHOOL OF ART, 167 RENFREW STREET	
A	**14**	CLYDEPORT LIMITED, 16 ROBERTSON STREET	
A	**15**	HYNDLAND PARISH CHURCH, 79 HYNDLAND ROAD	
A	**16**	52-56 LANGSIDE DRIVE	
A	**17**	6 PARK CIRCUS	
A	**18**	10 WOODSIDE CRESCENT	
A	**22**	PARKHEAD CONGREGATIONAL CHURCH	17-19 WESTMUIR ST
A	**23**	6 ROTTENROW EAST & 1 MCLEOD ST	BARONY HALL, UNIVERSITY OF STRATHCLYDE
A	**24**	GOVAN SHIPBUILDERS, 1048 GOVAN ROAD	
A	**28**	ST ANDREW'S CATHEDRAL	168 CLYDE STREET
A	**29**	ST AGNES	694 BALMORE ROAD
A	**30**	ST MARY'S	99 ABERCROMBY STREET
A	**31**	ST MARY IMMACULATE	SHAWHILL ROAD
A	**32**	ST ALOYSIUS	6,10 HILLKIRK STREET
A	**33**	CHURCH OF THE SACRED HEART	50-56 OLD DALMARNOCK ROAD
A	**34**	HOLY CROSS	109 DIXON AVENUE
A	**35**	ST HELEN'S	32 LANGSIDE AVENUE
A	**36**	ST ALBERT'S	149-153 ALBERT DRIVE
A	**37**	ST ANTHONY'S	831 GOVAN ROAD
A	**39**	ST ALOYSIO	23,25 ROSE STREET
A	**40**	ST PATRICK'S	55 NORTH ST & 101 WILLIAM ST
A	**41**	ST PETER'S PARTICK	HYNDLAND STREET
A	**42**	ST ALPHONSUS, CALTON	LONDON ROAD
A	**44**	ST SIMON'S	PARTICK BRIDGE STREET
A	**45**	BATTLEFIELD EAST	1208-1220 CATHCART ROAD G42 9EU
A	**45B**	BATTLEFIELD EAST (CHURCH HALL)	1208-1220 CATHCART ROAD G42 9EU
A	**46**	MOUNT FLORIDA PARISH CHURCH	1123 CATHCART ROAD G44 5UW
A	**47**	BROOMHILL	64 RANDOLF ROAD, MARLBOROUGH AVENUE G11 7JL
A	**48**	POLLOCKSHIELDS	525-529 SHIELDS ROAD G41 2RF
A	**49**	LINTHOUSE/ST KENNETH'S	9 SKIPNESS DRIVE G51 4RS
A	**50**	GOVAN OLD PARISH CHURCH	866,868 GOVAN ROAD
A	**51**	LANSDOWNE PARISH CHURCH	416,420 GREAT WESTERN ROAD, 4333 NORTH WOODSIDE ROAD G4 9HS
A	**52**	MOSSPARK PARISH CHURCH	167 ASHKIRK DRIVE G52 1LA
A	**53**	EASTBANK PARISH CHURCH	679 OLD SHETTLESTON ROAD G32 7JG
A	**54**	CARNTYNE OLD CHURCH	862 SHETTLESTON ROAD G32 7DP
A	**55**	MERRYLEA PARISH CHURCH	78,80 MERRYLEA ROAD G43 2QZ
A	**56**	QUEEN'S PARK	170 QUEEN'S DRIVE G42 8QZ
A	**57**	CATHCART TRINITY	90,92 CLARKSTON ROAD G44
A	**58**	ST JAMES' (POLLOCK)	LYONCROSS ROAD
A	**59**	SHERBROOKE ST GILBERTS	240 NITHSDALE ROAD G41 5AD
A	**60**	JORDANHILL PARISH CHURCH	28 WOODEND DRIVE G13 1QT
A	**61**	CARMYLE PARISH CHURCH	135 CARMYLE AVENUE
A	**62**	BALSHAGRAY	230 BROOMHILL DRIVE, BROOMHILL CROSS G11 7PZ
A	**63**	SHETTLESTON OLD PARISH CHURCH	85,111 KILLIN STREET G32 9AH
A	**64**	EASTWOOD PARISH CHURCH	5 MANSEWOOD ROAD G43
A	**65**	RENFIELD ST STEPHEN'S	256A BATH STREET, G2 4JP
A	**66**	CARDONALD PARISH CHURCH	2141 PAISLEY ROAD WEST G52 3PF
A	**67**	HIGH CARNTYNE	358 CARNTYNEHALL ROAD G33 6LW
A	**68**	CARMUNNOCK PARISH CHURCH	KIRK ROAD
A	**69**	ST JOHN'S-RENFIELD	16-22 BEACONSFIELD ROAD G12 0NY
A	**70**	SHAWLANDS CROSS	1114 POLLOCKHAWS ROAD, 7 MOSS-SIDE ROAD G41 3DG
A	**71**	GOVANHILL TRINITY	28 DAISY STREET G42 8JL
A	**122**	ST ANDREW'S EAST	681 ALEXANDRA PARADE, 6 EASTER CRAIGS G31 3LN
A	**123**	POLLOCKSHAWS PARISH	223 SHAWBRIDGE STREET G43
A	**124**	DENNISTOUN CENTRAL CHURCH	9 ARMADALE ST G31 3UU
A	**72**	ST MUNGO'S RC	94 DUKE STREET
A	**73**	MOUNT FLORIDA PRIMARY	1127 CATHCART ROAD & CARMUNNOCK ROAD
A	**74**	HOLMLEA PRIMARY	352-362 HOLMLEA ROAD, TULLOCH ST
A	**75**	HOLY CROSS PRIMARY	318 CALDER STREET, HOLLYBROOK ST
A	**76**	GOLFHILL PUBLIC	1,13 CIRCUS DRIVE
A	**77**	DENNISTOUN PUBLIC, ST DENNIS RC	129 ROSELEA DRIVE
A	**78**	ALEXANDRA PARADE PUBLIC	139, 220 ARMADALE ST 7 ALEXANDRA PARADE
A	**79**	TUREEN STREET	35 TUREEN STREET
A	**81**	CUTHBERTSON PRIMARY	35 CUTHBERTSON STREET 7 COPLAW ST
A	**82**	NOTRE DAME HIGH	160 OBSERVATORY ROAD
A	**83**	HILLHEAD HIGH SCHOOL	44 OAKFIELD AVENUE 7 37 SOUTHPARK AVE
A	**84**	TEMPLE PRIMARY SCHOOL	6 SPENCER STREET
A	**85**	NEWARK DRIVE NURSERY	10 NEWARK DRIVE
A	**86**	HOLYROOD RC	ALBERT ROAD & 60 DIXON RD
A	**88**	ELMVALE PRIMARY	104 ELMVALE ST, 712 HAWTHORN ST
A	**89**	LANGSIDE PRIMARY	201 7 233 TANTALLON ST
A	**91**	ANNETTE STREET PRIMARY	13 ANNETTE STREET
A	**92**	DRUMOYNE PRIMARY	200 SHIELDHALL ROAD
A	**93**	CRAIGHOLME SCHOOL INFANT DEPT	328 ALBERT DRIVE
A	**94**	SPRINGBURN NURSERY	48,54 GOURLAY STREET
A	**95**	ST JAMES PUBLIC	88 GREEN STREET
A	**97**	LONDON ROAD	1147 & 1167 LONDON ROAD
A	**98**	BATTLEFIELD PRIMARY	44 CARMICHAEL PLACE
A	**99**	SCOTLAND STREEET	225 SCOTLAND STREET
A	**100**	WOODSIDE PUBLIC, ALBANY ANNEX	44 ASHLEY STREET
A	**101**	NURSERY SCHOOL & SUMMERTOWN CENTRE	71 BROOMLOAN ROAD
A	**102**	GARNETBANK PRIMARY	221 RENFREW STREET

Table 1. List of surveyed buildings ('A' buildings)

LIST	*No*	*PROPERTY OR BUILDING*	*ADDRESS DETAILS*
A	**103**	POLLOCKSHIELDS PRIMARY	241 ALBERT DRIVE 7 HERRIET ST
A	**104**	ROYSTON (FORMERLY ST ROLLOX)	102 ROYSTON ROAD
A	**105**	PARKHOUSE SCHOOL	165 GLENHEAD STREET, 24 KIPPEN ST
A	**106**	HYNDLAND PUBLIC	12 AIRLIE STREET
A	**107**	WOODSIDE PUBLIC	311 WOODLANDS ROAD
A	**108**	HILLHEAD PRIMARY	15, 21 CECIL STREET
A	**110**	LORNE STREET	58,62 LORNE STREET
A	**111**	SHAKESPEARE PRIMARY	75 HOTSPUR STREET
A	**112**	HAGHILL PRIMARY	42 MARWICK STREET & 9-29 WALTER ST
A	**113**	HYNDLAND PRIMARY	40-44 FORTROSE STREET
A	**114**	WILLOWBANK PRIMARY	WILLOWBANK STREET
A	**115**	QUEEN MARY ST NURSERY	MONTGOMERY ST & 22 QUEEN MARY ST
A	**116**	NOTRE DAME PRIMARY	66 VICTORIA CRESCENT
A	**117**	EASTBANK ACADEMY	1346—1364 SHETTLESTON ROAD
A	**118**	FORMER BELLAHOUSTON ACADEMY ANNEX MAIN BLOCK	423 PAISLEY ROAD WEST
A	**119**	KELVINSIDE ACADEMY	20 BELLSHAUGH ROAD
A	**120**	ST MUNGOS ACADEMY	998 GREAT WESTERN ROAD
A	**125**	6 DOUNE QUADRANT	
A	**126**	SANDYFORD-HENDERSON MEMORIAL CHURCH	13 KELVINHAUGH STREET
A	**127**	ST MARGARET'S TOLLCROSS PARK CHURCH	179 BRAIDFAULD STREET

Table 2. List of surveyed buildings ('B' buildings)

LIST	*No*	*PROPERTY OR BUILDING*	*ADDRESS DETAILS*
B	**1**	CALEDONIA ROAD CHURCH	CALEDONIA ROAD CHURCH
B	**2**	QUEEN MARY STREET CHURCH	QUEEN MARY ST/MONTGOMERY ST
B	**3**	BROOMLOAN ROAD PUBLIC SCHOOL	BROOMLAW ROAD PUBLIC SCHOOL
B	**4**	ST CONVALS PRIMARY SCHOOL (SHAWHILL SCHOOL)	SHAWLANDS
B	**9**	NEW CATHCART CHURCH	212 NEWLANDS ROAD
B	**10**	STABLES, 56 PARTICKHILL RD	MAIN VILLA IS A7
B	**12**	ELECTRICITY SUBSTATION 'BRAIDFAULD ST 10'	10 BRAIDFAULD STREET
B	**13**	TENEMENT	82 EASTERHILL PLACE
B	**14**	TENEMENT	EVERSLEY ST/1170 TOLLCROSS RD
B	**15**	TOLLCROSS MEDICAL CENTRE	1101-1105 TOLLCROSS RD
B	**16**	TENEMENT	20/22 SCOTSTOUN STREET
B	**17**	TENEMENT	128/130 FORE STREET
B	**18**	WHITEINCH HOMES	19 WESTLAND DRIVE
B	**19**	PROVANHALL HOUSE	AUCHENLEA ROAD
B	**20**	UNIVERSITY OF GLASGOW	54 HILLHEAD STREET
B	**21**	UNIVERSITY OF GLASGOW	67/69 OAKFIELD AVENUE
B	**22**	UNIVERSITY OF GLASGOW	WOLFSON BUILDING
B	**23**	UNIVERSITY OF GLASGOW	ANDERSON COLLEGE, DUMBARTON ROAD
B	**24**	UNIVERSITY OF GLASGOW	MAIN BUILDING, HUNTER HALLS
B	**25**	HILLHEAD HIGH SCHOOL	54 SOUTHPARK AVENUE
B	**26**	THE FAÇADE	GLASGOW NECROPOLIS
B	**27**	JEWISH PILLAR + GATEWAY	GLASGOW NECROPOLIS
B	**28**	DELTA AREA (HEADSTONES: CRAWFORD & CORBETT)	GLASGOW NECROPOLIS
B	**29**	MACKENZIE	GLASGOW NECROPOLIS
B	**30**	CHARLES TENNANT	GLASGOW NECROPOLIS
B	**31**	BEATTIE	GLASGOW NECROPOLIS
B	**32**	MONTEITH MAUSOLEUM	GLASGOW NECROPOLIS
B	**33**	WILLIAM BLACK	GLASGOW NECROPOLIS
B	**35**	THE TRAMWAY	25 ALBERT DRIVE
B	**38**	BLAIRTUMMOCK HOUSE	BLAIRTUMMOCK HOUSE
B	**39**	END TENEMENT	25 DON STREET
B	**40**	NAPIERSHALL SCHOOL LODGE	39 NAPIERSHALL ST
B	**42**		127&129 MAIN ST, BALLIESTON
B	**43**	DALDOWIE DOOCOT	74 HAMILTON ROAD, BROOMHOUSE
B	**44**	TENEMENT	544 HAMILTON ROAD
B	**45**		12 & 13 GILLIES LANE, BAILLIESTON
B	**46**		9 MANSIONHOUSE DRIVE, SPRINGBOIG
B	**47**	TENEMENT	130 BUDHILL AVENUE
B	**48**	CARNTYNE PHARMACY	CARNTYNE ROAD
B	**49**	SHETTLESTON COOPERATIVE SOCIETY	SHETTLESTON HOUSING ASSOC. 65 PETTIGREW ST.
B	**50**	LLOYDS TSB/BANKING HOUSE	981 SHETTLESTON ROAD
B	**51**	ST MUNGO'S DAY CENTRE	31 MCASLIN STREET
B	**52**	MARTYR'S SCHOOL	
B	**53**	TENEMENT	18 SOUTH VESALIUS STREET
B	**54**	TENEMENT	607 SHETTLESTON ROAD
B	**55**	KNOWE LODGE	301 ALBERT DRIVE
B	**56**		52-58 DARNLEY ST
B	**57**	GOVANHILL POOL	CALDER STREET
B	**58**	SUBSTATION	CALDER STREET/ARDBEEY LANE
B	**59**	GOVANHILL LIBRARY	LANGSIDE RD/CALDER ST
B	**60**	MOUNT FLORIDA MEDICAL CENTRE	184 PROSPECTHILL RD
B	**61**	BURNHOUSE PUBLIC BATHS	BURNHOUSE ST, MARYHILL
B	**62**	MARYHILL BURGH HALL	1513 MARYHILL ROAD (GAIRBRAID AV, MARYHILL)
B	**63**	GAIRBRAID CHURCH	BURNHOUSE ST, MARYHILL
B	**64**	TENEMENT	1-2 HOLYROOD CRESCENT
B	**65**	DIXON COMMUNITY CARERS CENTRE	657 CATHCART RD
B	**66**	CAMPHILL HOUSE	QUEENS PARK
B	**67**	VICTORIA INFIRMARY	LANGSIDE ROAD
B	**68**	TENEMENT	15 OVERDALE AVE, BATTLEFIELD
B	**69**	HOLMWOOD HOUSE	NETHERLEE PLACE
B	**70**	AITKENHEAD HOUSE	KINGS PARK
B	**71**	TENEMENT	24 ORKNEY STREET, GOVAN
B	**72**	SHED	OLD GOVAN DOCKS, STAG STREET
B	**73**	TOWER	OLD GOVAN DOCKS, STAG STREET
B	**74**		8 SCOTLAND STREET
B	**75**		195 SCOTLAND STREET
B	**76**		14 STROMNESS STREET
B	**77**		12 STROMNESS STREET
B	**78**		171 SCOTLAND STREET
B	**79**		27 GREENHEAD STREET
B	**80**	GLASGOW GREEN STATION	BINNIE PLACE
B	**81**	FORMER TERRACE	3 MCPHAIL STREET
B	**82**	BRIDGETON PUBLIC LIBRARY	LANDRESSY STREET, BRIDGETON
B	**83**	TENEMENT	46 DALMARNOCK ROAD, BRIDGETON

Table 2. List of surveyed buildings ('B' buildings)

LIST	*No*	*PROPERTY OR BUILDING*	*ADDRESS DETAILS*
B	**84**	FORMER THEATRE	LONDON ROAD, BRIDGETON
B	**85**	TENEMENT	579 LONDON ROAD, BRIDGETON
B	**86**	MOSESFIELD HOUSE	STOBHILL PARK
B	**87**	TENEMENT	32 ST MONANCE STREET
B	**88**	FORMER STABLES?	STOBHILL HOSPITAL
B	**89**	ST. AUGUSTINE'S CATHOLIC CHURCH	ASHGILL ROAD
B	**90**	ENTRANCE ARCH LAMBHILL CEMETERY	BALMORE ROAD
B	**91**	CANAL WAREHOUSE 'THE STABLES'	BALMORE ROAD, LAMBHILL
B	**92**	BT TELEPHONE EXCHANGE	MALLOCH STREET, MARYHILL
B	**93**	BRIDGE	GARSCUBE ESTATE
B	**94**	QUEENS CROSS CHURCH	MARYHILL/ GARSCUBE ROAD
B	**95**	TENEMENT	41 BENVIEW STREET, RUCHILL
B	**96**	RUCHILL HOSPITAL NORTH GATEHOUSE	BILSLAND DRIVE (WESTERN GATEHOUSE OF TWO)
B	**98**	SPRINGBURN CROSS TENEMENTS	COWLAIRS ROAD, SPRINGBURN
B	**99**	SPRINGBURN PUBLIC HALLS	KEPPOCHHILL ROAD, SPRINGBURN
B	**100**	FORMER CARNEGIE LIBRARY & MUSEUM	ATLAS SQUARE, SPRINGBURN
B	**101**	BUILDING 23, STOBHILL HOSPITAL	
B	**102**	STOBHILL HOSPITAL	BASE OF MAIN TOWER
B	**103**	CASTLEMILK STABLES	54 MACHRIE ROAD, CASTLEMILK
B	**104**	ENTRANCE GATE	2 FERNHILL ROAD
B	**105**	BURREL COLLECTION	POLLOCK PARK
B	**106**	GATEHOUSE/ LODGE OF POLLOCK HOUSE	POLLOCK PARK
B	**107**	POLLOCK HOUSE	POLLOCK PARK
B	**108**	BARN	BLAIRBETH GOLF CLUB, FERNBRAE, CASTLEMILK
B	**109**		EARLSPARK AVENUE
B	**110**	TENEMENT	26 HILLHEAD STREET
B	**111**	TENEMENT	24 HILLHEAD STREET
B	**112**	TENEMENT	43 KERSLAND STREET
B	**113**	TENEMENT	39 KERSLAND STREET, HILLHEAD
B	**114**		4 LOUDON TERRACE
B	**115**	TENEMENT	5 CRANFORTH STREET
B	**116**	ST VINCENT'S CHURCH	ST VINCENT'S STREET
B	**117**		92 WEST GEORGE ST
B	**118**	CUSTOM HOUSE	298 CLYDE ST
B	**119**	MERCHANTS HOUSE	30 GEORGE SQ
B	**120**		101-111 BUCHANAN ST
B	**121**	JOHN ST. ARCH	JOHN STREET
B	**122**		55-59 BUCHANAN ST
B	**123**		208 WEST GEORGE ST
B	**124**		204 WEST GEORGE ST
B	**125**	CENOTAPH	GEORGE SQ
B	**126**		286 CLYDE ST
B	**127**	SACO HOUSE	53 COCHRANE ST
B	**128**	STOCK EXCHANGE	157 BUCHANAN ST
B	**129**		41 WELLSHOT ROAD
B	**130**	MCLENNAN ARCH	GLASGOW GREEN
B	**131**	ST MUNGO'S CATHEDRAL	(GLASGOW) CATHEDRAL
B	**132**	BLIND ASYLUM	88A-94 CASTLE STREET

Table 3. Definition of decay types and Stone Decay Codes used for the façade surveys.

LOSS OF STONE MATERIAL			
Back weathering & surface detachment	**BW**	Loss of stone material parallel to the original stone surface due to detachment of external crusts with adherent stone material.	**BWcr**
		Loss of flakes and scaling of material generally parallel to the stone surface, including case hardeneing.	**BWs**
		Loss of regular laminae of uniform thickness which parallel the stone surface, but not related to stone structure. Contour Scaling.	**BWcs**
		Loss of grains or granules leading to loss of stone material generally parallel to the stone surface. Crumbly granular disintegration.	**BWgr**
		Loss of stone aggregates or pieces generally parallel to the stone surface.	**BWag**
		Exfoliation of natural stone layers parallel to the masonry surface, including face-bedding.	**BWx**
		Detachment resulting from splitting of natural layers in the stone, including delamination.	**BWsl**
Relief weathering	**R**	Rounding of edges and hollowing out, typically producing concave/convex forms.	**Ro**
		Alveolar (honeycomb) weathering.	**Ra**
		Changes in surface relief resulting from variations in stone structure such as bedding, foliation, banding etc. Frequent striped pattern. Including 'soft beds'.	**Rsb**
		Weathering out of specific stone components such as selective weathering of softer clay/mud lenticles, or loss of compact components such as pebbles, fossil fragments, concretions etc. Common hole-shaped forms.	**Rsl**
Break Out. Loss of competent stone fragments	**BO**	Loss due to anthropogenic impact such as vandalism, vehicle strike, abrasion, fire, and damage due to bad workmanship.	**BOa**
		Loss due to interaction with other (mostly foreign) materials in the structure such as expansion of corroding iron inserts.	**BOm**
		Loss due to external physical effectssuch as wedge effect of plant roots, subsidence, structural problems etc.	**BOn**
		Break out due to non recognizable causes	**BO**
DISCOLOURATION AND SURFACE DEPOSITS			
Discolouration. Alteration of the original stone colour by processes other than cleaning	**D**	Changing colouration such as oxidation of iron and manganese components in the stone or biogenic pigments.	**Dc**
		Bleaching. Loss of colour due to processes such as leaching or washing out.	**Db**
Soiling. Surface dirt deposits	**S**	Soiling by particles from the atmosphere, mainly grey to black deposits of dust, soot, fly ash etc.	**Sp**
		Soiling by particles from water. Generally poorly adhesive, mainly grey to brown deposits of dust, soil or mud particles.	**Sw**
		Soiling by droppings from birds (guano deposits).	**Sg**
		Soiling due to anthropogenic impact such as paint, graffiti, posters, etc.	**Sa**
Salt deposits	**SD**	Efflorescence: deposits on the stone surface.	**SDe**
		Sub-florescence: deposits beneath the stone surface, typically in the zone of detachment of scales.	**SDs**
Crust	**C**	Dark-coloured crust tracing the stone surface, such as extraneous gypsum crust.	**Ct**
		Dark-coloured crust changing the surface of the stone.	**Cc**
Biogenic colonization	**BC**	Microbiological colonization: microflora such as fungi, algae, lichen and bacteria. Biofilms.	**BCm**
		Colonization by higher plants	**BCh**
FISSURES/DEFORMATION			
Fissures/Cracks	**FS**	Fissures independent of the stone structure, e.g. structural failure	**FSi**
		Fissures related to natural structures in the stone such as joints, fractures, veins.	**FSd**
Deformation/Movement	**DF**	Bending or movement of masonry	**DF**

Table 3. Definition of decay types and Stone Decay Codes used for the façade surveys.

OTHERS			
Cement Patch Repair	**PR**	Cement repair or coating on stone surface: 'Plastic Repair'.	**PR**
Cement pointing	**CP**	Hard cement pointing present in mortar joints.	**CPp**
		Hard cement pointing in mortar joints with damage to adjacent stone.	**CPd**
Repointing Required	**RR**	Open joints, requiring repointing with mortar.	**RR**
Previous stone repair	**SR**	Previous stone replacement	**SR**
Other materials replacing stone	**OM**	Previous repairs using materials other than stone.	**OM**
Missing stone	**MS**	Stone removed or absent.	**MS**
Changes due to cleaning or application of chemical treatments	**CL**	Physical damage caused by abrasive cleaning such as grit blasting or mechanical disking.	**CLp**
		Damage leading to loss of stone resulting from chemical cleaning.	**CLc**
		Staining of stone surface due to application of chemical treatments.	**CLs**
Damp areas (water saturated stone)	**DP**	Damp areas with loss of stone.	**DPsl**
		Damp areas with loss of mortar.	**DPml**
		Damp areas: intact	**DP**
Painted stone	**OP**	Overpainting of stone surface with no evidence of damage.	**OP**
		Overpainting of stone surface with evidence of damage to underlying or adjacent stone.	**OPd**

Table 4. List of stone samples from buildings

No	Building	Sample No	Sandstone Colour	Macroscopic analysis	Microscopic analysis	Stone Type	Original source (cited)	Original source (petrographic)
A1	176 DUKE STREET, KIRKHAVEN	ED10077	BLONDE	Y	Y	B2		
A2	110-136 (EVEN) FLEMINGTON ST	ED9932	RED	Y	Y	R2		Gatelawbridge
A8	ST GEORGE'S TRON PARISH CHURCH	ED10056	BLONDE	Y	Y	B4		
A9	158 INGRAM STREET	ED10083	BLONDE	Y	Y	B3		
A12	PEARCE INSTITUTE, GOVAN	ED10047	BLONDE	Y	Y	B3	Mix of Dullatur, Black Pasture and	
A13	167 RENFREW STREET (second phase)	ED10074	BLONDE	Y	Y	B4		
A13	167 RENFREW STREET (first phase)	ED10075	BLONDE	Y	Y	B2a		
A15	79 HYNDLAND ROAD, HYNDLAND PARISH CHURCH	ED9961	RED	Y	Y	R2	Ballochmyle	
A16	54 LANGSIDE DRIVE,	ED9902	RED	Y	Y	R1		
A23	6 ROTTENROW EAST & 1 MCLEOD STREET	ED10061, ED10062	RED	Y	Y	R2	Ballochmyle	
A24	1048 GOVAN RD, GOVAN SHIPBUILDERS	ED10049	RED	Y	Y	R3		
A27	33 SALTOUN ST	ED9977-C	RED	Y	Y	R4		
A27	33 SALTOUN ST	ED9977-A	RED	Y	Y	R4		
A27	33 SALTOUN ST	ED9977-B	RED	Y	N	R4		
A29	ST AGNES	ED9945	RED	Y	Y	R3	Locharbriggs	
A30	ST MARY'S	ED9926	BLONDE	Y	Y	B2		
A31	ST MARY IMMACULATE	ED10084	BLONDE	Y	Y	B3		
A33	CHURCH OF THE SACRED HEART	ED9909	RED	N	N			
A34	HOLY CROSS	ED9913	RED	N	N			
A35	ST HELEN'S	ED10053	BLONDE	Y	Y	B5		
A35	ST HELEN'S	ED10071	BLONDE	Y	Y	B5		
A36	ST ALBERTS	ED10069	BLONDE	Y	Y	B4		
A40	ST PATRICKS	ED10067	RED	Y	Y	R1		Gatelawbridge
A45	BATTLEFIELD EAST	ED10073	RED	Y	Y	R2		
A46	MOUNT FLORIDA PARISH CHURCH	ED10078	BLONDE	Y	Y	B3		
A47	BROOMHILL	ED10050	RED	Y	Y	R2		Cornclockle
A48	POLLOCKSHIELDS	ED9914	BLONDE	Y	Y	B2		
A49	LINTHOUSE/ST KENNETH'S	ED10063	RED	Y	Y	R3		Gatelawbridge or Ballochmyle?
A50	GOVAN OLD PARISH CHURCH	ED10055	BLONDE	Y	Y	B3		
A55	MERRYLEA PARISH CHURCH	ED10065	BLONDE	Y	Y	B3		
A56	QUEENS PARK	ED10082	BLONDE	Y	Y	B2		
A57	CATHCART TRINITY	ED10076	BLONDE	Y	Y	B2		
A59	SHERBROOKE ST GILBERTS	ED10081	BLONDE	Y	Y	B2		
A60	JORDANHILL PARISH CHURCH	ED9943	RED	Y	Y	R1		
A61	CARMYLE PARISH CHURCH	ED9960	RED	Y	Y	R1		Dalreoch?
A62	BALSHAGRAY	ED10051	RED	Y	Y	R3		Gatelawbridge or Locharbriggs?
A63	SHETTLESTON OLD PARISH CHURCH	ED9911	RED	Y	Y	R1		Gatelawbridge
A65	RENFIELD ST STEPHENS	ED10080	BLONDE	Y	Y	B2		
A66	CARDONALD PARISH CHURCH	ED10066	RED	Y	Y	R3		
A68	CARMUNNOCK PARISH CHURCH	ED9920	BLONDE	Y	Y	B5		
A69	ST JOHN'S-RENFIELD	ED10052	BLONDE	Y	Y	B2		
A70	SHAWLANDS CROSS	ED9918	BLONDE	Y	Y	B2		
A71	GOVANHILL TRINITY	ED9908	BLONDE	Y	Y	B2		
A72	ST MUNGO'S RC	ED10079	BLONDE	Y	Y	B3		
A73	MOUNT FLORIDA PRIMARY	ED9955	RED	Y	Y	R3		Gatelawbridge or Ballochmyle?
A74	HOLMLEA PRIMARY	ED9957	RED	N	N			
A75	HOLY CROSS PRIMARY	ED9954	RED	Y	Y	R2		Ballochmyle
A76	GOLFHILL PUBLIC	ED9929	RED	N	N			
A78	ALEXANDRA PARADE PUBLIC	ED10064	RED	Y	Y	R3		Gatelawbridge or Ballochmyle?

Table 4. List of stone samples from buildings

No	Building	Sample No	Sandstone Colour	Macroscopic analysis	Microscopic analysis	Stone Type	Original source (cited)	Original source (petrographic)
A79	TUREEN STREET	ED9953	BLONDE	Y	Y	B4		
A81	CUTHBERTSON PRIMARY	ED9956	RED	Y	Y	R2		Ballochmyle
A82	NOTRE DAME HIGH	ED9962	BLONDE	N	N			
A83	HILLHEAD HIGH SCHOOL	ED9948	BLONDE	Y	Y	B2a		
A84	TEMPLE PRIMARY SCHOOL	ED9964	BLONDE	Y	Y	B4		
A86	HOLYROOD RC	ED9952	BLONDE	N	N			
A88	ELMVALE PRIMARY	ED9947	RED	Y	Y	R3		Corncockle/Locharbriggs?
A89	LANGSIDE PRIMARY	ED9916	RED	Y	Y	R1		
A91	ANNETTE STREET PRIMARY	ED10070	BLONDE	Y	Y	B2		
A93	CRAIGHOLME SCHOOL INFANT DEPT	ED9919	BLONDE	Y	N	B2		
A94	SPRINGBURN NURSERY	ED9946	BLONDE	Y	Y	B2		
A95	ST JAMES PUBLIC	ED9928	RED	N	N			
A97	LONDON ROAD	ED9912	RED	Y	Y	R3		Locharbriggs/Corncockle?
A98	BATTLEFIELD PRIMARY	ED9904	RED	Y	Y	R1	Corsehill	
A101	NURSERY SCHOOL & SUMMERTOWN CENTRE	ED9903	RED	Y	Y	R3		Corncockle
A102	GARNETBANK PRIMARY	ED9999	RED	Y	Y	R2		Gatelawbridge
A103	POLLOCKSHIELDS PRIMARY	ED10072	BLONDE	Y	Y	B3		
A104	ROYSTON (FORMERLY ST ROLLOX)	ED9933	RED	N	N			
A110	LORNE STREET	ED10048	RED	Y	Y	R2		Locharbriggs/Gatelawbridge?
A111	SHAKESPEARE PRIMARY	ED9944	RED	Y	Y	R2		Gatelawbridge
A112	HAGHILL PRIMARY	ED9930	RED	Y	Y	R3		Ballochmyle
A115	QUEEN MARY ST NURSERY	ED9927	RED	Y	Y	R3		Ballochmyle
A116	NOTRE DAME PRIMARY	ED9963	RED	Y	Y	R2		Corncockle/Locharbriggs?
A117	EASTBANK ACADEMY	ED9910	RED	Y	Y	R3		Ballochmyle
A118	FORMER BELLAHOUSTON ACADEMY	ED10054	BLONDE	Y	Y	B4		
A122	ST ANDREW'S EAST	ED9959	BLONDE	Y	Y	B2		
A123	POLLOCKSHAWS PARISH	ED10068	BLONDE	Y	Y	B2		
A124	DENNISTOUN CENTRAL CHURCH	ED9958	BLONDE	Y	Y	B3		
B1	CALEDONIA ROAD CHURCH	ED9915	BLONDE	Y	Y	B2		
B3	Broomloan Road Public School	ED9921	BLONDE	Y	Y	B2		
B4	St Convals Primary School (Shawhill School)	ED9917	RED	N	N			
B6	Springburn Public Halls	ED9901	RED	Y	Y	R3		Locharbriggs/Corncockle?
B9	NEW CATHCART CHURCH	ED9972	RED	Y	Y	R1		
B9	NEW CATHCART CHURCH	ED9973	RED	Y	Y	R1		
B13	82 EASTERHILL PLACE	ED9976	RED	Y	Y	R4		Bellshill/Dalreoch?
B18	19 WESTLAND DRIVE (DRESSINGS)	ED9979-2	RED	Y	Y	R2		Corncockle?
B18	19 WESTLAND DRIVE (RUBBLE)	ED9979-1	RED	Y	Y	R4		
B24	UNIVERSITY OF GLASGOW, MAIN BUILDING	ED100027-B	BLONDE	Y	Y	B2a		
B24	UNIVERSITY OF GLASGOW, MAIN BUILDING	ED100027-C	BLONDE	Y	Y	B4		
B26	THE FAÇADE (CARVED URN)	ED9994-A	BLONDE	Y	Y	B2		
B26	THE FAÇADE	ED9994-B	BLONDE	Y	Y	B2		
B34	230 NORTH WOODSIDE ROAD	ED10003	BLONDE	Y	Y	B4		
B35	THE TRAMWAY	ED10001	BLONDE	Y	Y	B2a		
B36	9 MANSIONHOUSE DRIVE, SPRINGBOIG	ED10002	BLONDE	Y	Y	B3		
B38	BLAIRTUMMOCK HOUSE	ED9996-D	BLONDE	Y	N	B2		
B38	BLAIRTUMMOCK HOUSE (WEST)	ED9996-C	BLONDE	Y	N	B3		
B38	BLAIRTUMMOCK HOUSE (PARAPET COPE)	ED9996-A	BLONDE	Y	N	B3		
B38	BLAIRTUMMOCK HOUSE	ED9996-B	BLONDE	Y	Y	B4		
B39	25 DON STREET	ED9998	RED	Y	Y	R2		Gatelawbridge
B40	NAPIERSHALL SCHOOL LODGE	ED9997	RED	Y	Y	R1		Gatelawbridge

Table 4. List of stone samples from buildings

No	Building	Sample No	Sandstone Colour	Macroscopic analysis	Microscopic analysis	Stone Type	Original source (cited)	Original source (petrographic)
B41	7-11 WELLINGTON ST	ED9991	BLONDE	Y	Y	B3		
B72	OLD GOVAN DOCKS, STAG STREET	ED10023-A	BLONDE	Y	Y	B2a		
B73	OLD GOVAN DOCKS (TOWER), STAG STREET	ED10023-B	BLONDE	Y	Y	B4		
B75	195 SCOTLAND STREET	ED10022	RED	Y	Y	R3		Ballochmyle
B78	171 SCOTLAND STREET	ED10021	RED	Y	Y	R4		
B80	GLASGOW GREEN STATION	ED10020	RED	Y	Y	R3		Ballochmyle
B87	32 ST MONANCE STREET	ED10011	RED	Y	Y	R2		Gatelawbridge/Ballochmyle?
B88	STOBHILL HOSPITAL	ED10015	RED	Y	Y	R3		
B90	LAMBHILL CEMETRY ARCHWAY, BALMORE ROAD	ED10017	BLONDE	Y	Y	B2a		Dalreoch?
B91	CANAL STABLES, FORTH AND CLYDE CANAL	ED10012	BLONDE	Y	Y	B4		
B92	BT TELEPHONE EXCHANGE, MALLOCH STREET	ED10010	RED	Y	Y	R4		Dalreoch?
B93	BRIDGE, GARSCUBE ESTATE	ED10013	RED	Y	Y	R4		
B94	QUEENS CROSS CHURCH	ED10005	RED	Y	Y	R2		Corncockle?
B96	RUCHILL HOSPITAL NORTH GATEHOUSE	ED10016	RED	Y	Y	R2		Gatelawbridge
B100	SPRINGBURN LIBRARY	E7747	RED	Y	Y	R2		Gatelawbridge
B103	CASTLEMILK STABLES	ED10018	BLONDE	Y	Y	B5		
B103	CASTLEMILK STABLES	ED10019	BLONDE	Y	N	B5		
B107	POLLOCK HOUSE	ED10025	BLONDE	Y	Y	B5		
B119	MERCHANTS HOUSE	ED10057	BLONDE	Y	Y	B2a		
B131	GLASGOW CATHEDRAL	ED9965-A	BLONDE	Y	Y	B1		
B131	GLASGOW CATHEDRAL	ED9965-B	BLONDE	Y	Y	B3		
B132	BLIND ASYLUM	ED10058	BLONDE	Y	Y	B5		
C4	WELLFIELD PUBLIC SCHOOL	ED10014	RED	Y	Y	R1		
C9	21 ROXBURGH STREET	ED10031-A	RED	Y	Y	R3		
C11	21 ROXBURGH STREET	ED10031-B	RED	Y	Y	R1		
C12	145 ST VINCENT STREET	ED10042	RED	Y	Y	R3		Locharbriggs
C13	36 ARDENLEA STREET, DALMARNOCK	ED10041	RED	Y	Y	R3		Ballochmyle

Table 5. Quarries known to have supplied stone to Glasgow, with recorded use of stone in buildings.

Quarry Name	Product	Rock Description	Places Used	Notes	Location Details
Annanlea	Sandstone			Resembles corsehill in colour and texture. Used in conjuction with Locharbriggs.	Dumfriesshire
Aucheneath	Sandstone	Crushed sandstone			Strathclyde Region
Auchinlea	Sandstone	Feldspathic sandstone, cream sandstone.	Western Infirmary		S of Glasgow
Avenuehead/ Avenue Head	Sandstone	Fine grained, pale buff sandstone.		Might also have quarried limestone.	Strathclyde Region
Balgray/ Balgrey	Sandstone			Mainly 1790-1840	Springburn, N Glasgow
Ballochmyle/ Mauchline	Sandstone	Red sandstone	Citizen Buildings, St Vincent Place (1886). Sun Buildings, Renfield Street. Hyndland Church, Hyndland Road (1885). Barony Church, Castle Street (1888). Royal Hospital for Sick Children, Scott Street, Garnethill (1887). Springburn Established Church, Hill Street (1889). Pillars at entrance of 24 Vincent Place.	Permian. Weathered well, rarely shows obvious bedding. Mauchline Sandstone	Mauchline, Ayrshire, S of Glasgow
Bannockburn	Sandstone		Construction of City Chambers and other buildings in Glasgow.	White to cream coloured sandstone, used in the 1880s.	near Plean, Stirlingshire
Barskimming	Sandstone		Masonic Hall, Ayr Street, Springburn. Established Church, Gower Street, Bellahouston.	Baird & Stevenson	Mauchline(red), Ayrshire
Bishopbriggs	Sandstone	Pale, blonde sandstone.	Main Entrance-Glasgow University, Dressings of Glasgow University.	Freestone of good quality. Mainly 1840-1890 Best stone mined. Major centre for quarries, became worked out by end 19th century.	N Glasgow
Black Pasture	Sandstone	Cream sandstone.	Mitchell Library. Former Parcel Office in Waterloo Street (with Prudham). Nos. 17-29 St Vincent Place. Parts of Pearce Institute, Govan (with Dullatur and Woodburn Northumberland), National Bank St Enoch Square upper part (Plean lower), New Mitchell Library, North Street. Engineers Institution, Elmbank Crescent. Nobels Explosive Co Limited, West Geoge Street. Nurses Home, Royal Infirmary. Scottish Provident Institution Buildings, St Vincent St		Northumberland, N of England
Blaxter	Sandstone		Scottish Legal Assurance Society buildings, Nos. 81-107 Bothwell Street, Standard Chartered Bank, Natural Philosophy building of Glasgow University.		Northumberland
Blochairn	Sandstone	Fine grained, pale buff-yellow sandstone. Laminated.			
Bogles of Gilmorehill	Sandstone	Walling stone. Whitish fine grained rock, compact with texture, streaked at intervals.			Gilmorehill. Quarry situated where the Western Infirmary and University buildings are.
Bonhill	Sandstone	Old Red Sandstone	Window pillars of Glasgow University.		Dumbartonshire
Bothwell Park or Bells	Sandstone	Sandstone - Barren Red Coal Measures. Red and white sandstone.		Closed 1913.	SE Glasgow
Braehead	Sandstone	Cross-bedded, soft.			E Glasgow

Table 5. Quarries known to have supplied stone to Glasgow, with recorded use of stone in buildings.

Quarry Name	Product	Rock Description	Places Used	Notes	Location Details
Braidbar (mines)	Sandstone			Last of the Giffnock quarries. Closed 1910	SW Glasgow
Brathay	Slate	Black Slate.	Uprights of 116-118 Buchanan Street (Saxone).	Silurian.	Southern Part of Lake District
Bredisholm	Sandstone	Medium grained pink sandstone. Red/pink sandstone, relatively clay-rich	Yoker Old Church, Dumbarton Road	Used for ashlar fronts. Closed 1909.	SE Glasgow
Breich South	Sandstone	Sandstone			Lothian Region
Brenshaw	Sandstone				SE Glasgow
Budhill	Sandstone	Sandstone. Argillaceous matrix.			E Glasgow, S of Shettleston station.
Burnfield	Sandstone			Historical quarry.	SW Glasgow
Byres road	Sandstone		Terraces.	19th century, cream coloured.	Byres Road. Location uncertain.
Cairngall	Granite		Pedestal of Duke of Wellington's Statue, Royal Exchange.	This is a fairly fine grained grey granite with small white feldspar phenocrysts. Historical quarry.	Aberdeenshire
Carmyllie	Sandstone	Fine Sandstone.	Flagstones at Glasgow University.		Near Arbroath
Carntyne	Sandstone				E Glasgow
Castlecary	Sandstone	White sandstone.			Central Region
Chapelhall	Sandstone	Cream sandstone.	Dressings belonging to Bute Hall in Glasgow University.		Near Airdrie, NS 76SE
Charing Cross					W Glasgow
Chatelherault	Sandstone	Sandstone.			Strathclyde Region
Closeburn	Sandstone	Red sandstone.	Upper stories of Strathclyde University, Kings Theatre and Charing Cross Mansions, West of Scotland Technical College. William McGeoch and Co Building, West Campbell Street.	resembles Locharbriggs sandstone.	Thornhill / Northen Dumfrieshire
Colston	Sandstone			Colston, Bishopbriggs	N Glasgow
Coltmuir	Sandstone			In Colston, Bishopbriggs	N Glasgow
Coltpark			Much stone for Glasgow.	Two quarries, North Coltpark and South Coltpark, very close by.	N Glasgow
Coplawhill	Sandstone				S Glasgow
Corncockle	Sandstone	Red sandstone, freestones	Ibrox Public School, Hinshelwood Drive, Ibrox. Principal Buildings in neighbourhood.	19th century.	Lochmaben, Dumfriesshire.
Correnie	Granite	Pink granite	The City Chambers.	Only base & balustrades made from pink Corrennie granite.	Aberdeenshire
Corrie	Sandstone	Red sandstone.	London School Road. James Simpson and Sons, Furniture Warhouse, Sauchiehall Street.		Arran
Corsehill	Sandstone		(Banks in London, shipped to North America)	Red sandstone, has a fine grain, and is more compact in texture than Locharbriggs, lighter in colour.	Dumfriesshire, near Annan
Cove	Sandstone	Red sandstone.	West of Scotland Technical College, Upper stories of Strathclyde University	Conjuction with Locharbriggs. Resembles Corsehill in colour and texture.	Dumfriesshire
Cowcaddens	Sandstone		Cathedral church. George square.	1700-1840. 1832 map of Glasgow's city center .	Glasgow's city center
Cowglen	Sandstone			Very gritty, brown. Small pre 1700-1890.	SW Glasgow
Cracklinghouse	Sandstone			1700-1790.	Central Glasgow
Craigash	Sandstone	Fine grained, very pale buff sandstone.			Strathclyde
Craigash	Sandstone	White, Hard, fine-grained sandstone, siliceous cement		Open c.1910.	Milngavie
Craigleith	Sandstone	Cream sandstone.	External steps and landings of Glasgow University, Glasgow University Main Building flagstones for steps and landings (1867-71)		Edinburgh
Craigpark (1)	Dolerite	Igneous, Whinstone, Quartz dolerite.			Between Glasgow and Edinburgh, near Livingston.
Craigpark (2)	Sandstone	Sandstone		From Lower Coal Measures.	East Central Glasgow. North of Necropolis.
Craigroot	Sandstone?		"used in Glasgow and Fort William station"		Queenzieburn, NE Kirkintilloch

Table 5. Quarries known to have supplied stone to Glasgow, with recorded use of stone in buildings.

Quarry Name	Product	Rock Description	Places Used	Notes	Location Details
Craigton	Sandstone	brownish with plant remains			W Glasgow
Croftamie Quarry	Sandstone	Sandstone			Central Region
Crowhill	Sandstone or limestone				N Glasgow
Cullalo / Cullaloe	Sandstone	White sandstone, good match to Craigleith			Fife
Dalmoak	Sandstone	Sandstone			Strathclyde Region
Dalreoch	Sandstone	Upper Old Red Sandstone			Strathclyde Region
Dalreoch	Sandstone	White sandstone - Upper ORS			Strathclyde Region, near Dumbarton.
Dawsholm	Sandstone				NW Glasgow
Dowanhill	Sandstone				Byres road, NW Glasgow.Very close to University buildings.
Drumcavel/ Drumcavil	Sandstone	Fine grained, pale buff sandstone. Fine, oxidised sandstone.			Lothian Region
Drumcousil	Sandstone	White and yellow sandstone.			Strathclyde Region
Dullatur	Sandstone	Coarse-grained, buff sandstone. Medium grained, pale fawn sandstone.	Town Hall, Kirkintilloch. Parts of Woodilee Asylum, Lenzie. Parts of Pearce Institute, Govan Cross (with Black Pasture and Woodburn Northumberland)		Strathclyde Region
Dunduff Quarry	Sandstone	Sandstone		Also andesite.	Strathclyde
Dunmore	Sandstone		City Chambers; Merchant's House, George Square; Central Railway Station, part facing Union Street; Post Office, George Square, West Side; Edinburgh Life Assurance Office, St Vincent Street; Bank of Scotland, St Vincent Place; Merchants House, West George Street; Established Church, Main Street, Rutherglen	White to grey to cream coloured sandstones, construction in 1880s. Baird & Stevenson. Closed 1906, but reopened late 20th century; imported by rail.	Bannockburn, Stirlingshire, near Grangemouth and Plean
Dunmore New	Sandstone			as above	
Eastfield	Sandstone	Medium grained, pale grey sandstone. Pink sandstone, relatively clay-rich	Bothwell and Silverbank Street, Cambuslang. South side od Calderwood Terrace, Rutherglen.	Baird & Stevenson. Closed 1911.	Cambuslang, SE Glasgow
Eastpark	Sandstone				NW Glasgow
English	?				SW Glasgow
Ewing's	Sandstone			Opened 1817 by James Ewing.	Central Glasgow
Fairy Knowe	Sandstone	Cream and red sandstone - Upper ORS			Strathclyde Region
Flag	Sandstone				SW Glasgow
Flemington	Sandstone				SE Glasgow
Furnace	Granite		Road setts	Pale and fine with small white feldspar phenocrystals.	Argyllshire
Gain	Sandstone	Fine, pale buff, sandstone with brownish laminae			Strathclyde
Garscube	Sandstone		Greenock Custom House (1820). Garscube and Blythswood Houses. Ashlar, stair steps and buildings.	Important in second part of 18th century; exported to Ireland and West Indies; near Forth & Clyde canal. Warm cream coloured stone. Light yellow.	NW Glasgow
Gartocharn	Sandstone	Lower Old Red Sandstone			Strathclyde Region
Gartverrie	Sandstone	Sandstone			
Gatelawbridge	Sandstone	Red sandstone. Fairly light orang-red in colour.	Allan Line Buildings, Bothwell Street. Sir John Neilson, Cuthbertson School, Coplaw Street. Towns and ports		Thornhill/northen Dumfrieshire
Germiston	Sandstone	Fine-grained white sandstone.			Strathclyde Region
Giffnock	Sandstone	Medium grained, pale buff sandstone. Cream sandstone. Contains carbonate. Freestone. Sandstone Upper Limestone Group. Carboniferous Limestone Series.	Much stone supplied to Glasgow. Glasgow University Main Building dressed stones (1867-71). Scottish Wholesale Cooperative Society building, Morrison Street. Head Office Glasgow Savings Bank, Ingram Street. Glasgow Academy. Central Railway Station, part facing Union Street. Post Office, George Square, East Side. Kelvingrove Art Gallery & Museum (interior).G.P.O, Central Station, Dressings of quadrangles in Glasgow University. Walter Scott statue in George Sq.	Mainly 1840-1890. Exhausted by 1900. Liver rock exported to Belfast, America, South Africa. Baird & Stevenson.	S Glasgow

Table 5. Quarries known to have supplied stone to Glasgow, with recorded use of stone in buildings.

Quarry Name	Product	Rock Description	Places Used	Notes	Location Details
Gilmorehill	Sandstone		Many walls in Glasgow University Main Building (1867-71).	Byres Road. White sandstone with streaks, quarry open specifically for University.	South of Great Western Road, very close to University buildings.
Glenyards Quarry	Sandstone	Quartzose Sandstone - 'Silica-rock' - Millstone Grit Series (upper part).			Strathclyde
Grange	Cream Sandstone		British Linen Bank, Queen Street, top story	Baird & Stevenson	Fife, Burntisland (white)
Grinshill Red	Sandstone	Red sandstone.	Buildings		Shropshire
Grinshill White	Sandstone	Cream sandstone.	Buildings		Shrophire
Hadene	Limestone		Foyer of Glasgow University.		Derbyshire
Hallside	Sandstone				SE Glasgow
Heathfield	Mudstone, shale	Sandstone.			Strathclyde Region
Hermand	Sandstone	Cream sandstone.	Former Inland Revenue offices, NE corner George Square (with Plean). Post Office, George Square, Ingram Street portion. Inland Revenue office George Street (with Overwood).		West Lothian, SW of Edinburgh
Heworth Burn	Sandstone		Base of mural at Glasgow University		Gateshead
Black Pasture	Sandstone		Mitchell Library		Northumberland
Hillhead	Could be Limestone			Mainly 1840-1890.	W Glasgow
Hillhousemuir	Sandstone	Banhead Grit.			Strathclyde Region
Homehills	Sandstone		Used locally (Cambuslang) and in Glasgow		Cambuslang
Humbie	Sandstone	Cream sandstone.	Former Royal Exchange Building, Queen Street. Royal Exchange (extension to Cunninghame mansion in 1828-29)	Built in 1829-1832.	West Lothian
Huntershill (Bishopbriggs)	Sandstone	Medium grained, pale fawn sandstone. Fine to medium grained, clay and carbonate bearing.	Used mainly in Glasgow, also Belfast (e.g. Belfast New Town Hall). Municipal Buildings, Clydbank. Glasgow University main building (with Giffnock) Additions to Western Infirmary.	Mined. Closed 1908.	In Bishopbriggs., N Glasgow
Hyndland	Sandstone		Hyndland road.	1842	old station park.West side
Inchneuk	Sandstone	Sandstone			Strathclyde Region
Janesfield/ Janefield	Sandstone			Carboniferous sandstone of the Clackmannan Group.	N Glasgow
John Baird	Sandstone	Sandstone			Strathclyde
Karribber (East Karribber)	Sandstone	Sandstone - Coal Measures.			Strathclyde Region
Kelvingrove	Sandstone			Mid- to late 19th century.	W Glasgow
Kelvinside	Sandstone				NW Glasgow
Kemnay	Granite	White/Grey	Cenotaph (war memorial), Sir John Moore's statue, Gladstone's statue and Robert Burns' statue in George Square.		
Kenmure	Sandstone		Much stone for Glasgow. Glasgow University Main Building dressed stones (1867-71)	In Bishopbriggs.	Bishopbriggs, N Glasgow.
Keppoch	Sandstone			Mainly 1790-1840.	N Glasgow
Kirkburn	Sandstone	Medium grained pale buff sandstone. White Sandstone, relatively clay-rich.	Used locally (Cambuslang) and in Glasgow.	Closed 1906.	SE Glasgow
Kirkland	Mudstone, shale	Dark carbonaceous shale.			Strathclyde Region
Knockendon	Sandstone	Seamill Formation.			Strathclyde Region
Laverock	Sandstone	Medium grained buff sandstone.			Srathclyde
Lazonby	Sandstone	Red sandstone.			Cumbria
Levenseat	Sandstone				Central Region

Table 5. Quarries known to have supplied stone to Glasgow, with recorded use of stone in buildings.

Quarry Name	Product	Rock Description	Places Used	Notes	Location Details
Locharbriggs	Sandstone	Red sandstone.	Kelvingrove Art Gallery (exterior), Hunter Barr and Co Building, Queen Street. Liberal Club, Buchanan Street. Conservative Club, Bothwell Street. Castle Chambers, Renfield Street. Norich Union Chambers, St Vincent Street. West of Scotland Technical College. 144 Hope Street. Burrell Museum. Peoples Palace. Royal Scottish Academy of Music & Drama.	Deep and dark red colour, of medium to fine texture Red sandstone.	Dumfriesshire
Lochcraigs	Sandstone	Soft sandstone.			Strathclyde
Magazine	Sandstone			1700-1840.	Central Glasgow
Magiscroft	Sandstone	Sandstone			Lothian Region
Mainhill	Sandstone				E Glasgow
Maryhill	?			Mainly 1840-1890.	W Glasgow
Millstone	Sandstone				Central Glasgow
Monkredding	Sandstone	Sandstone, with muscovite and orthoclase and albite.		Baird & Stevenson	Kilwinning
Montgomery	Sandstone			Baird & Stevenson	Tsarbolton
Mosesfield			Probably used in Mosesfield House.	Carboniferous sandstone of the Clackmannan Group.	N Glasgow
Muirhouse	Sandstone	Sandstone above Douglas Muir Quartz Conglomerate			Strathclyde Region
Muirhouse Farm	Sandstone	Hard sandstone.			Strathclyde Region
Netherton, Netherton of Garscube	Sandstone	White/Cream 'Liver' Freestone, Good weathering. In one database is mentioned as limestone.	Similar to 'St Andrew's Church', Nos. 248 and 250 West George Street. Estate of sir Archibald Cross.	Mainly 1790-1890, 400 yards from the Forth and Clyde Canal.	NW Glasgow, North-Anniesland Cross
New Braidbar	Sandstone				SW Glasgow
New Giffnock	Sandstone				SW Glasgow
New Red Hollington	Red sandstone		St Margarets Church, Knightswood (1929-32).	Last major stone building in Glasgow.	Staffordshire
Nitshill	Sandstone			Some mining.	SW Glasgow
North Woodside	Sandstone				NW Glasgow
Orchard	?				SW Glasgow
Overwood	Sandstone	Medium grained buff cream sandstone.	Former Inland Revenue Buildings, George Square, The Stock Exchange. Sanitary Chambers, Montrose Street. Stock Exchange, Buchanan Street. Clydesdale Bank, St Vincent Place. St Andrews Halls, Berkeley Street. Mann, Byars and Co Building, Glassford Street. Inland Revenue office George Street (with Hermand).	Baird & Stevenson	Near Stonehouse, Lanarkshire
Partick Bridge					W Glasgow
Partick Bridge	Sandstone			16th Century. Close to University buildings & Huntarian Museum.	Benalder street Bridge.Very close to University buildings.
Partick Cross	Sandstone			Where Kelvinhall subway station sits today is where the quarry used to be in the 19th century.	Dowan vale house
Peterhead	Granite		34-38 West George Street. The City Chambers. Equestrian statues to Prince Albert and Queen Victoria. Columns in The Scottish Provident building, also in the old General Post Office.	In the City Chambers: lower storey has pillars and balustrades made of the granite which is pink, In entrance hall, this Peterhead granite rests on pedestals of Aberdeen granite. In Equestrian Statues, polished chests of pink Peterhead granite are set upon unpolished grey granite.	NE Scotland
Plean	cream Sandstone		National Bank, Trongate. Former Inland Revenue offices, NE corner George Square (with Hermand). National Bank St Enoch Square (lower part; Black Pasture upper)	Closed 1907.	Stirlingshire, near Falkirk

Table 5. Quarries known to have supplied stone to Glasgow, with recorded use of stone in buildings.

Quarry Name	Product	Rock Description	Places Used	Notes	Location Details
Pollock				Small pre 1700-1890.	S Glasgow
Polmaise	Sandstone		City Chambers (with Dunmore) of Glasgow	white to cream coloured sandstones, construction in 1880s. Closed 1909.	near Plean, near Stirling
Polmont	Sandstone	Coarse-grained, buff sandstone.			Strathclyde
Portland	Limestone		Cladding on Nos 84-9 St Vincent Street (1908-9) Office of Northern Assurance Co. Ltd, St Vincent St. Debenhams building in Argyll St.		Dorset
Possil, Possilpark	Sandstone		Hutcheson's Hall (1802-5) with some Woodside.	Mainly 1790-1840.	N Glasgow
Provanside (Bells)	Sandstone			Pre 1700-1840.	Central Glasgow
Prudham	Sandstone		Former Parcel Office (post Office), Waterloo Street (with Black Pasture).		Northumberland
Queenzieburn	Sandstone	Fine grained pale fawn sandstone. Slightly yellowish / white sandstone, mica-rich.			NE Kirkintilloch
Robroyston	Sandstone				N Glasgow
Rosebank	Sandstone				N Glasgow
Ross of Mull	Granite		Main Entrance-Glasgow University (pillars). 34-38 West George Street.		West Coast
Shap	Granite	Pink granite with large feldspar crystals.	The balustrade of 24 Vincent Place, Kerbstones of NW corner of West George St & Hope St, Pillars in the hallway of Glasgow University former Evening Citizen building in St Vincent Place.	Porphyritic with phenocrystals 2cm long of pink feldspar.	Cumbria
Shettleston	Sandstone				E Glasgow
Smithstone	Sandstone	Sandstone resting on Ayrshire Bauxitic Clay.			Central Region
Smithstone	Sandstone	Soft sandstone.			Strathclyde Region
South Balgrey/ South Balgray	Sandstone				NW Glasgow
Springwell	Sandstone	Cream sandstone.	New' office block on N side of George Square, Biochemistry building of Glasgow University.		County Durham
St. Bees	Sandstone	Red Sandstone.			Near St. Bees Head, Cumbria
Stainton	Sandstone	Cream sandstone.	Bank of England.		Near Barnard Castle, County Durham
Stancliffe	Sandstone	Whitish, gritty sandstone.	Various Buildings.		Derbyshire
Stanton Moor	Sandstone	Pale cream sandstone, fine gritstone.	Various Buildings.	Various quarries.	SSW of Sheffield, Derbyshire
Stirlinghill	Granite	Flesh-pink granite	Strathclyde University (main building)	Commonly shows good xenoliths.	Peterhead, closed NE Scotland, active
Stockingfield	Sandstone				NW Glasgow
Stonelaw	Sandstone				S Glasgow
Temple	Sandstone				NW Glasgow
Thornwood	Sandstone				SE Glasgow
Town	Sandstone			1700-1840.	Central Glasgow
Trinleybrae	Sandstone				NW Glasgow
Wellshot	Sandstone			Also Sand and Gravel.	SE Glasgow
Wemyss Bay	Sandstone	Red sandstone.	Ardgowan Terrace in Sauchiehall Steet, The Bridge carrying Dumbarton Road over the Kelvin. Partick Bridge	Poor weathering properties, often conglomeratic & poorly cemented. Old Red Sandstone	Ayrshire
Westfield	Sandstone	Red and white sandstone.		Closed 1902.	S Glasgow
Westmuir					E Glasgow
White Craigs	Sandstone	Kinnesswood Fm - within cornstone. 'Busby Sandstone' - below Clyde Lavas.			Strathclyde Region
Wildshaw	Quartz Sandstone, chert	Siliceous rock. Ganister.			Strathclyde
Williamwood					SW Glasgow

Table 5. Quarries known to have supplied stone to Glasgow, with recorded use of stone in buildings.

Quarry Name	Product	Rock Description	Places Used	Notes	Location Details
Woodburn			Parts of Pearce Institute, Govan Cross (with Dullatur and Black Pasture).		Northumberland
Woodhall	Sandstone	Crushed sandstone.			Strathclyde Region
Woodside		Light yellow.	Hutcheson Hospital, Ingram Street. Ashlar, stair steps and buildings. Used for part of Hutcheson's Hall (1802-5)	Was in peak production from about 1790 to around 1850.	South of Great western Road
<u>Country</u>					
Norway			Sun Alliance office block, Hope Street.	At the entrance the floor is paved with the described rock.	
Finland			Bradford & Bingley Buliding Society, Gordon Street.	Pink oolitic limestone blocks in a finer grained matrix.	
Sweden			Scottish Amicable Assurance, Hope Street.	Dark in colour & shows distinct banding when viewed in large blocks.	
Sweden	Igneous.		Samuels at corner of Buchanan St & Argyle St.	This is coarsely crystalline & has patches made almost entirely of red feldspars.	
Oslo fjord area of Norway			Ground floor The Royal Bank of Scotland, 92-100 Buchanan St.	This rock is a very coarse grained Syenite.	
Finland			The Royal Bank of Scotland, Gordon Street.	A black and white medium grained granite.	
Tunisia			Entrance to Hume House, West George St.		
Cornwall			James Watt Pedestal.		
Dorset			84-94 St Vincent St, Ashley House (corner of Wellington St & West George St), Glasgow University (Southern gable of James Watt building).	Ashley House is made of the highly fossilferous Portland Roach (columns only).	
Italy			Sun Alliance office block. Hope Street.	Principal facing stone above ground level only.	
Argentina			Clysdale Bank Headquarters, Buchanan Street.	Coarse looking, red & grey in colour.	
Italy			Leicester Building Society, Hope Street.		

Table 6. Stone quantity and Mason time calculations for 'A' facades

List	PROPERTY or BUILDING	Stone Type* (Red/Blonde)	Random Block (tonnes)	Banker Mason (days)	Site Mason (days)	Carver (days)
A1	176 DUKE STREET, KIRKHAVEN	B	49	50	96	43
A2	110-136 FLEMINGTON ST	R	5	6	18	0
A3	1-10 (INCLUSIVE) MORAY PL.	B	7	28	15	0
A4	6 ROWAN RD CRAIGIE HALL, DRUMBECK **(x4)**	B	28	20	48	0
A5	76 UNIVERSITY AVE, WELLINGTON UNITED FREE CHURCH	B	38	41	74	0
A7	56 PARTICKHILL RD, 'WOODBANK'	B	0	0	0	0
A8	163 BUCHANAN ST & NELSON MANDELA PL ST GEORGE'S TRON PARISH CHURCH	B	17	22	101	0
A10	79-91 (ODD) GLASSFORD ST	B	38	109	79	0
A11	190 TRONGATE & 2-4 (EVEN) GLASSFORD ST	B	14	14	32	0
A12	840,860 GOVAN RD & RETURN ELEVATION **(x2)**	B	70	166	142	0
A13	167 RENFREW ST & 11,15 DALHOUSIE ST **(x3)**	B	12	0	42	0
A14	16 ROBERTSON ST, CLYDE NAVIGATION	B	0	0	7	0
A15	79 HYNDLAND ROAD, HYNDLAND PARISH CHURCH	R	28	20	70	0
A16	52-56 (EVEN) LANGSIDE DRIVE,	B	2	1	5	0
A17	1-29 (INCLUSIVE) PARK CIRCUS	B	3	0	5	0
A18	6-19 (INCLUSIVE) WOODSIDE CRESCENT	B	11	16	23	0
A22	PARKHEAD CONGREGATIONAL CHURCH	B	181	68	452	0
A23	6 ROTTENROW EAST & 1 MCLEOD ST	R	3	4	15	0
A24	1048 GOVAN RD, GOVAN SHIPBUILDERS	R	20	30	39	0
A28	ST ANDREW'S CATHEDRAL	B	6	16	12	0
A29	ST AGNES	R	4	11	23	0
A30	ST MARY'S	B	80	33	172	0
A31	ST MARY IMMACULATE	B	13	55	41	0
A32	ST ALOYSIUS	B	23	25	50	0
A33	CHURCH OF THE SACRED HEART	R	23	25	58	0
A34	HOLY CROSS	R	0	0	0	0
A35	ST HELEN'S	M	4	9	11	0
A36	ST ALBERT'S	B	9	5	22	0
A37	ST ANTHONY'S	M	17.5	19	38	0
A39	ST ALOYSIO	R	3	7	13	0
A40	ST PATRICK'S	R	5	22	25	0
A41	ST PETER'S PARTICK	R	1	5	11	0
A42	ST ALPHONSUS, CALTON	R	1.5	7	8	0
A44	ST SIMON'S	B	32	36	69	0
A45	BATTLEFIELD EAST (RED) **(x3)**	R	3.84	6	12	0
A45B	BATTLEFIELD EAST (BLONDE) **(x3)**	B	0.39	24	12	0
A46	MOUNT FLORIDA PARISH CHURCH	B	17	19	33	0
A47	BROOMHILL	R	1	0	3	0
A48	POLLOCKSHIELDS	B	20	26	41	0
A49	LINTHOUSE/ST KENNETH'S	R	30	32	72	0
A50	GOVAN OLD PARISH CHURCH	B	7	3	39	0
A51	LANSDOWNE PARISH CHURCH	B	7	20	17	0
A52	MOSSPARK PARISH CHURCH **(x4)**	R	4	4	16	0
A53	EASTBANK PARISH CHURCH	R	21	33	50	0
A54	CARNTYNE OLD CHURCH	B	17	42	43	0
A55	MERRYLEA PARISH CHURCH **(x5)**	B	0	0	0	0
A56	QUEEN'S PARK	B	4	11	19	0
A57	CATHCART TRINITY	B	18	17	37	0
A58	ST JAMES' (POLLOCK) **(x3)**	B	0	3	3	0
A59	SHERBROOKE ST GILBERTS	B	7	16	12	0
A60	JORDANHILL PARISH CHURCH	R	7	14	28	0
A61	CARMYLE PARISH CHURCH	R	4	10	10	0
A62	BALSHAGRAY	R	3	5	13	0
A63	SHETTLESTON OLD PARISH CHURCH	B	13	19	40	0
A64	EASTWOOD PARISH CHURCH	B	8	4	37	0
A65	RENFIELD ST STEPHEN'S	B	48	61	120	0
A66	CARDONALD PARISH CHURCH	R	2	2	4	0
A67	HIGH CARNTYNE	M	1.2	3	3	0
A68	CARMUNNOCK PARISH CHURCH	B	0	0	2	0

Table 6. Stone quantity and Mason time calculations for 'A' facades

List	PROPERTY or BUILDING	Stone Type* (Red/Blonde)	Random Block (tonnes)	Banker Mason (days)	Site Mason (days)	Carver (days)
A69	ST JOHN'S-RENFIELD	B	8	19	25	0
A70	SHAWLANDS CROSS	B	5	28	11	0
A71	GOVANHILL TRINITY	B	39	85	85	0
A72	ST MUNGO'S RC	B	40	22	74	0
A73	MOUNT FLORIDA PRIMARY	R	0	0	4	0
A74	HOLMLEA PRIMARY	R	4	6	9	0
A75	HOLY CROSS PRIMARY	R	7	13	26	0
A76	GOLFHILL PUBLIC **(x3)**	R	36	72	75	0
A77	DENNISTOUN PUBLIC, ST DENNIS RC	B	99	109	261	0
A78	ALEXANDRA PARADE PUBLIC	R	8.5	10	17	0
A79	TUREEN STREET	B	58	38	128	0
A81	CUTHBERTSON PRIMARY	R	3	4	29	0
A82	NOTRE DAME HIGH	B	0	0	5	0
A83	HILLHEAD HIGH SCHOOL	M	1.5	1	9	0
A84	TEMPLE PRIMARY SCHOOL	B	2	4	20	0
A85	NEWARK DRIVE NURSERY	B	4.6	5	20	0
A86	HOLYROOD RC	M	0	0	0	0
A88	ELMVALE PRIMARY	R	6	2	26	0
A89	LANGSIDE PRIMARY **(x2)**	R	56	84	134	0
A91	ANNETTE STREET PRIMARY	B	9	10	31	0
A92	DRUMOYNE PRIMARY	M	1	2	9	0
A93	CRAIGHOLME SCHOOL INFANT DEPT	B	12	20	19	0
A94	SPRINGBURN NURSERY	B	41	72	112	0
A95	ST JAMES PUBLIC	R	23	35	80	0
A97	LONDON ROAD	R	8	15	25	0
A98	BATTLEFIELD PRIMARY	R	3	5	14	0
A99	SCOTLAND STREEET SCHOOL **(x2)**	R	18.4	26	18	0
A100	WOODSIDE PUBLIC, ALBANY ANNEX	B	1	2	3	0
A101	NURSERY SCHOOL & SUMMERTOWN CENTRE	R	3	6	20	0
A102	GARNETBANK PRIMARY	R	2	2	24	0
A103	POLLOCKSHIELDS PRIMARY	B	36.5	3	70	0
A104	ROYSTON (FORMERLY ST ROLLOX)	R	16	5	76	0
A105	PARKHOUSE SCHOOL	M	1	1	5	0
A106	HYNDLAND PUBLIC	R	0	0	0	0
A107	WOODSIDE PUBLIC	B	7.5	6	11	0
A108	HILLHEAD PRIMARY	B	32	56	67	0
A110	LORNE STREET	R	4	6	15	0
A111	SHAKESPEARE PRIMARY	R	8	11	27	0
A112	HAGHILL PRIMARY	R	25	39	93	0
A113	HYNDLAND PRIMARY	B	43	37	91	0
A114	WILLOWBANK PRIMARY	R	19	9	41	0
A115	QUEEN MARY ST NURSERY	R	23	33	58	0
A116	NOTRE DAME PRIMARY **(x2)**	R	0	0	38	0
A117	EASTBANK ACADEMY	R	17	22	41	0
A118	FORMER BELLAHOUSTON ACADEMY	B	14	17	29	0
A119	KELVINSIDE ACADEMY	B	27	46	60	0
A120	ST MUNGOS ACADEMY	B	29	101	54	0
A122	ST ANDREW'S EAST	B	2	5	6	0
A123	POLLOCKSHAWS PARISH	B	2	2	8	0
A124	DENNISTOUN	B	35	26	70	0
A125	6 DOUNE QUADRANT	B	14	4	27	0
A126	SANDYFORD-HENDERSON MEMORIAL CHURCH	B	1	2	6	0
A127	ST MARGARET'S TOLLCROSS PARK CHURCH	R	2	1	4	0

***Stone Type: **R**ed/**B**londe/**M**ixed/**G**ranite/**L**imestone
Figures in parenthesis represent correction factors for buildings where full facade was not surveyed (see text for explanation)

Table 7. Stone quantity and Mason time calculations for 'B' facades

List	PROPERTY or BUILDING	Stone Type* (Red/Blonde)	Random Block (tonnes)	Banker Mason (days)	Site Mason (days)	Carver (days)
B1	CALEDONIA ROAD CHURCH	B	172	118	338	0
B2	QUEEN MARY STREET CHURCH	B	17	43	42	0
B3	BROOMLOAN ROAD PUBLIC SCHOOL	B	6	4	19	0
B4	ST CONVAL'S PRIMARY SCHOOL (SHAWHILL SCHOOL)	R	9	12	19	0
B9	NEW CATHCART CHURCH	R	9	15	30	0
B10	STABLES, 56 PARTICKHILL RD, 'WOODBANK',	B	1	3	3	0
B12	ELECTRICITY SUBSTATION 'BRAIDFAULD ST 10'	R	0.5	1	4	0
B13	81 EASTERHILL PLACE	R	36	15	76	0
B14	EVERSLEY ST/1170 TOLLCROSS RD	B	30	5	64	0
B15	1101-1105 TOLLCROSS RD	B	21	22	49	0
B16	20/22 SCOTSTOUN STREET	B	24	10	53	0
B17	128/130 FORE STREET	R	12	8	17	0
B18	WHITEINCH HOMES, 19 WESTLAND DRIVE	R	21	32	53	0
B19	PROVANHALL HOUSE, AUCHENLEA ROAD	M	2	2	6	0
B20	UNIVERSITY OF GLASGOW, 54 HILLHEAD STREET	B	29	12	50	0
B21	UNIVERSITY OF GLASGOW, 67/69 OAKFIELD AVENUE	B	44	13	94	0
B22	UNIVERSITY OF GLASGOW, WOLFSON BUILDING	B	5	12	31	0
B23	UNIVERSITY OF GLASGOW, ANDERSON COLLEGE	B	9	10	18	0
B24	UNIVERSITY OF GLASGOW, MAIN BUILDING, HUNTER HALLS **(x2.5)**	B	30	75	87.5	0
B25	HILLHEAD HIGH SCHOOL	B	3.5	3	9	0
B26	THE FAÇADE	B	17	39	36	44
B27	JEWISH PILLAR + GATEWAY	B	2	0	0	42
B28	DELTA AREA	B	1	2	3	17
B29	MACKENZIE	B	3	1	2	0
B30	CHARLES TENNANT	M	0.09	0	2	23
B31	BEATTIE	M	0	0	1	0
B32	MONTEITH MAUSOLEUM	B	54	494	128	257
B33	WILLIAM BLACK	M	4	11	5	52
B35	THE TRAMWAY, 25 ALBERT DRIVE	B	21	24	60	0
B38	BLAIRTUMMOCK HOUSE	B	4	3	8	0
B39	25 DON STREET	R	0	0	0	0
B40	NAPIERSHALL SCHOOL LODGE	R	1	1	7	0
B42	127&129 MAIN ST, BALLIESTON	R	1	2	3	0
B43	DALDOWIE DOOCOT	R	3	11	5	0
B44	544 HAMILTON ROAD	R	9	3	20	0
B45	12 & 13 GILLIES LANE, BAILLIESTON	B	7	4	12	0
B46	9 MANSIONHOUSE DRIVE, SPRINGBOIG	B	1	1	3	0
B47	130 BUDHILL AVENUE	R	9	11	19	0
B48	CARNTYNE PHARMACY	R	0	0	1	0
B49	SHETTLESTONE HOUSING ASSOC.	R	18	6	38	0
B50	LLOYDS TSB/BANKING HOUSE	M	0	0	1	0
B51	ST MUNGO'S DAY CENTRE	B	5	1	16	0
B52	MARTYR'S SCHOOL	R	0	1	1	0
B53	18 SOUTH VESALIUS STREET	B	7	1	17	0
B54	607 SHETTLESTON ROAD	R	2	1	5	0
B55	KNOWE LODGE	B	0	0	0	0
B56	52-58 DARNLEY ST	R	9	2	18	0
B57	GOVANHILL POOL	R	3	2	13	0
B58	SUBSTATION, CALDER STREET	R	1	1	8	0
B59	GOVANHILL LIBRARY	B	6	13	21	0
B60	MOUNT FLORIDA MEDICAL CENTRE	R	1	4	11	0
B61	BURNHOUSE PUBLIC BATHS	B	5	17	21	13
B62	MARYHILL BURGH HALL	B	41	31	82	0
B63	GAIRBRAID CHURCH	B	2	2	7	0
B64	1-2 HOLYROOD CRESCENT	B	29	16	63	0
B65	DIXON COMMUNITY CARERS CENTRE	B	5	5	15	0
B66	CAMPHILL HOUSE	B	1	0	2	0
B67	VICTORIA INFIRMARY	B	5	3	12	0

Table 7. Stone quantity and Mason time calculations for 'B' facades

List	PROPERTY or BUILDING	Stone Type* (Red/Blonde)	Random Block (tonnes)	Banker Mason (days)	Site Mason (days)	Carver (days)
B68	15 OVERDALE AVE, BATTLEFIELD	M	12	10	24	0
B69	HOLMWOOD HOUSE	B	0	0	1	0
B70	AITKENHEAD HOUSE	B	0	2	2	0
B71	24 ORKNEY STREET, GOVAN	R	10	2	19	0
B72	OLD GOVAN DOCKS BUILDING, STAG STREET	B	4	7	13	0
B73	OLD GOVAN DOCKS TOWER, STAG STREET	B	3	5	6	0
B74	8 SCOTLAND STREET	B	13	12	28	0
B75	195 SCOTLAND STREET	R	7	12	16	0
B76	14 STROMNESS STREET	B	18	8	38	0
B77	12 STROMNESS STREET	B	7	8	42	0
B78	171 SCOTLAND STREET	R	4	13	9	0
B79	27 GREENHEAD STREET	B	104	46	212	0
B80	GLASGOW GREEN STATION	R	28	105	72	0
B81	3 MCPHAIL STREET	B	0	0	0	0
B82	BRIDGETON PUBLIC LIBRARY	B	7	21	16	0
B83	46 DALMARNOCK ROAD, BRIDGETON	B	23	15	47	0
B84	LONDON ROAD, BRIDGETON	R	40	36	88	0
B85	579 LONDON ROAD, BRIDGETON	R	43	33	84	0
B86	MOSESFIELD HOUSE	B	1	1	7	0
B87	32 ST MONANCE STREET	R	6	3	14	0
B88	STOBHILL HOSPITAL, FORMER STABLES	B	1	1	7	0
B89	ST. AUGUSTINE'S CATHOLIC CHURCH	B	0	0	3	0
B90	ENTRANCE ARCH, BALMORE ROAD	B	2	1	10	0
B91	CANAL STABLES, FORTH AND CLYDE CANAL	B	4	5	18	0
B92	BT TELEPHONE EXCHANGE, MALLOCH STREET	R	5	12	15	0
B93	BRIDGE, GARSCUBE ESTATE	B	13	0	25	0
B94	QUEENS CROSS CHURCH	R	7	13	26	0
B95	41 BENVIEW STREET	M	6	2	13	0
B96	RUCHILL HOSPITAL NORTH GATEHOUSE	R	6	5	17	0
B98	SPRINGBURN CROSS	R	124	12	242	0
B99	SPRINGBURN PUBLIC HALLS	R	34	54	112	0
B100	SPRINGBURN LIBRARY	R	1	5	4	0
B101	BUILDING 23, STOBHILL HOSPITAL	R	8	7	16	0
B102	STOBHILL HOSPITAL, BASE OF MAIN TOWER	R	2	2	5	0
B103	CASTLEMILK STABLES	B	2	1	22	0
B104	ENTRANCE GATE **(x2)**	B	0	0	2	0
B105	BURREL COLLECTION	R	0	0	2	0
B106	GATEHOUSE/ LODGE OF POLLOCK HOUSE	B	1	1	5	0
B107	POLLOCK HOUSE	B	5	2	11	0
B108	BLAIRBETH GOLF CLUB	M	11	2	29	0
B109	EARLSPARK AVENUE	R	6	1	17	0
B110	26 HILLHEAD STREET	B	33	11	71	0
B111	24 HILLHEAD STREET	B	2	1	10	0
B112	43 KERSLAND STREET	B	5	4	19	0
B113	39 KERSLAND STREET, HILLHEAD	B	39	9	81	0
B114	4 LOUDON TERRACE	B	8	3	22	0
B115	5 CRANFORTH STREET	R	31	14	64	0
B116	ST VINCENT'S CHURCH	B	115	221	196	44
B117	92 WEST GEORGE ST	L	15	2	29	0
B118	CUSTOM HOUSE	B	73	60	146	0
B119	MERCHANTS HOUSE	B	35	72	72	0
B120	101-111 BUCHANAN ST	B	2	3	6	0
B121	JOHN ST ARCH, CITY CHAMBERS	B	0	0	4	0
B122	55-59 BUCHANAN ST	B	2	6	5	0
B123	208 WEST GEORGE ST	B	1	7	4	0
B124	204 WEST GEORGE ST	B	6	6	12	0
B125	CENOTAPH, GEORGE SQ	G	0	0	0	0
B126	286 CLYDE ST	B	85	137	183	0

Table 7. Stone quantity and Mason time calculations for 'B' facades

List	PROPERTY or BUILDING	Stone Type* (Red/Blonde)	Random Block (tonnes)	Banker Mason (days)	Site Mason (days)	Carver (days)
B127	53 COCHRANE ST	B	17	7	33	0
B128	STOCK EXCHANGE, 157 BUCHANAN ST	B	6	34	13	0
B129	41 WELLSHOT ROAD	R	0	0	6	0
B130	MCLENNAN ARCH	B	9	7	8	0
B131	ST MUNGO'S CATHEDRAL	B	42	128	84	0
B132	BLIND ASYLUM, CASTLE STREET	B	38	37	79	45

***Stone Type: **R**ed/**B**londe/**M**ixed/**G**ranite/**L**imestone

Figures in parenthesis represent correction factors for buildings where full facade was not surveyed (see text for explanation)