QUARRY BANK MILL, STYAL,

CHESHIRE

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SUMMARY

Following proposals to upgrade the visitor experience at Quarry Bank Mill, Styal, Cheshire (centred on SJ 836 829), the National Trust commissioned OA North to undertake a programme of research and building and topographic survey at the mill. Quarry Bank Mill is afforded statutory designation as a Grade II* listed building, reflecting the immense importance of the site as one of the best preserved former textile-manufacturing complexes in the country. The survey was undertaken in accordance with a project design by OA North, which was itself informed by a project brief by the National Trust. The project entailed the implementation of a desk-based study, and a detailed fabric survey by means of laser scanning, photogrammetry and instrument survey. The survey was followed by a process of description and analysis and culminated with the production of the present report. The survey was undertaken between May and December 2013.

Quarry Bank Mill was established in 1784 in the wake of the successful application of mechanised cotton spinning by Richard Arkwright, and the resultant birth of the factory-based textile industry. Samuel Greg leased land from the Earl of Stamford to construct Quarry Bank Mill, which was one of the first generation water-powered cotton-spinning mills, and was designed to produce coarse warps using water frames. In 1796 Greg embarked on a programme of expansion at the mill, which entailed the extension of the building to the south. The mill underwent substantial expansion in 1817-20 with the construction of the New Mill, which was equipped with the largest of the mill's waterwheels. A further enlargement of the mill was undertaken at some time prior to 1834 with the construction of the Greg Rooms to the south of the New Mill.

Samuel Greg was succeeded by Robert Hyde Greg in 1832, who decided to install powerlooms at Quarry Bank. This prompted the next major phase of development, with the construction of a large weaving block in 1836-7, elevating the complex to an integrated spinning and weaving mill, typical of the 1830s. However, an overhaul of the steam-power plant was undertaken prior to the construction of this weaving block, necessitated by the increased requirements of the then proposed powerlooms. A new steam engine was supplied by Boulton and Watt, which was housed in a new two-storey structure, of standard beam engine house design, placed transversely against the northern end of the Old Mill. The diversification into powerloom weaving was evidently successful, as another weaving block was added to the site in 1839. Unusually for a weaving block, however, this building was a three-storey structure, perhaps reflecting the limited space available for a large single-storey weaving shed.

In 1870, on the retirement of his father, the mill came under the sole control of Edward Hyde Greg, who embarked upon a major programme of improvements and invested in new machinery. Cotton spinning at Quarry Bank ceased in 1894, and from then until its closure the mill was used only for weaving. Robert Alexander Greg took over control of the business in 1900, and the 1900s brought both an expansion in the weaving capacity of Quarry Bank Mill and the introduction to the mill of the Northrop loom, but there were no new buildings constructed. The decade also saw the replacement of the waterwheel with a turbine system, and heavy gearing replaced by rope drives.

In 1939, following several decades of decline in the business, Alexander Greg donated a large part of the estate, including Quarry Bank Mill, to the National Trust, but limited production continued. Between 1930s to 1950, the work force fell from 178 to just 13, and production finally ceased in 1959.

Quarry Bank Mill faced dereliction by the late 1960s, and between 1968 and 1976 over £240,000 was spent on its repair. In 1976 the Quarry Bank Mill Trust Limited, an independent charitable trust, was set up with the aim of opening the mill as an industrial museum and leased the buildings from the National Trust. The first room was opened to the public in 1978. In 1984, 200 years after it had been first built as a cotton factory, Quarry Bank Mill won the Museum of the Year Award. In 2001, the National Trust took over responsibility for the running of the site.

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Oxford Archaeology North would like to thank Jamie Lund, the National Trust Archaeologist, for the invitation to undertake the project and for considerable support during the project. Thanks are also due to the staff of Quarry Bank Mill for their co-operation and support during the course of the project, in particular we must thank Phyllis Bailey, Chris Guffog, Andy Cragg and Craig Brack. Thanks are also expressed to the staff at Manchester Archives for facilitating the documentary research.

The desk-based research was carried out by Dr Peter Arrowsmith. The topographic survey was undertaken by Jamie Quartermaine, and the building survey was undertaken by Graham Mottershead, Karl Taylor, Lewis Stitt and Chris Wild. The laser scanning was undertaken by Tom Avery of APR Services Ltd, and we are also grateful to Tony Rogers for his help in facilitating the survey. The analysis was undertaken by Chris Wild, who also compiled the fabric survey report, and the illustrations were produced by Anne Stewardson. The project was managed by Jamie Quartermaine and Ian Miller, who both edited the report. We would also like to thank Mike Williams of English Heritage and Marilyn Palmer of Leicester University for their input and advice during editing.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF THE PROJECT

1.1.1 Following proposals to upgrade the visitor experience at Quarry Bank Mill, Styal, Cheshire (centred on SJ 836 829), the National Trust commissioned OA North to undertake a programme of research and building and topographic survey at the mill. Quarry Bank Mill is afforded statutory designation as a Grade II* listed building, reflecting the immense importance of the site as one of the best-preserved former textile-manufacturing complexes in the country. The survey was undertaken in accordance with a project design by OA North (2012), which was itself informed by a project brief by the National Trust (2012). The project entailed the implementation of a desk-based study, and a detailed fabric survey by means of laser scanning, photogrammetry and instrument survey. The survey was followed by a process of description and analysis and culminated with the production of the present report. The survey was undertaken between May and December 2013.

1.1.2 The desk-based research provides a context within which to understand the results of the building and topographic surveys. This work has provided a detailed survey record of the mill in its current state, and informs the interpretation of the mill, its development, and the tasks and processes that took place in the different parts of the structure as well as the proposals for upgrading the visitor experience at the mill.

1.1.3 The survey has provided a large 3D dataset from multiple survey techniques, which was used to compile 2D plans, elevations, and cross-sections and provides the basis for understanding and managing the building. In addition the dataset provides a valuable digital archive for any further analysis or recording.

1.2 SITE LOCATION, GEOLOGY AND TOPOGRAPHY

1.2.1 Quarry Bank Mill lies to the south of Styal village and is situated close to the apex of a broad sweeping curve of the River Bollin (Fig 1 and Plate 1). The river in this area runs through a V-shaped valley to the north of Wilmslow, in the Macclesfield Borough of Cheshire East. The mill lies at approximately 55m (aOD) and the landscape immediately to the north and west is dominated by woodland, formal gardens, and parkland, whilst that to the south and east consists primarily of agricultural field systems.

1.2.2 The underlying solid geology of the area comprises Helsby Sandstone dating to the Triassic period (250-200 million years ago), whilst the superficial geology is composed of Devensian (10,000-70,000 BP) Glaciofluvial sands and gravel (Countryside Commission 1998, 148-9).

Plate 1: An aerial view of Quarry Bank Mill, looking east

2. METHODS

2.1 INTRODUCTION

2.1.1 The project was undertaken in accordance with the Project Design submitted by OA North (2012), which was informed by a Project Brief by the National Trust (2012). All work was consistent with the relevant standards and procedures of the Institute for Archaeologists (IfA), (IfA 2011, *Standard and Guidance for Archaeological Desk-based Assessments*; IfA 2010 *Code of Conduct*; English Heritage 2006a, *Management of Research Projects in the Historic Environment* (MoRPHE)); English Heritage 2006b, *Understanding Historic Buildings: A Guide to Good Recording Practice,* and generally-accepted best practice.

2.2 DESK-BASED ASSESSMENT - SOURCES

2.2.1 The desk-based assessment sought primarily to collate the wealth of documentary research that has been undertaken previously and included a thorough review of sources made available by the National Trust. These sources included published sources, in addition to numerous unpublished documents and primary archival material. Other principal sources of information consulted were historical and modern maps of the study area and information held by the NTSMR for Quarry Bank Mill, as well as further published and unpublished secondary sources. Information was also drawn from the East Cheshire Textile Mill Survey, the Greater Manchester Textile Mill Survey, and the Lancashire Textile Mill Survey.

2.2.2 ***Documentary Sources:*** by comparison with the fairly slight documentation available for many textile sites, the material which exists for Quarry Bank Mill is exceptional in its quantity and detail. This is largely due to the survival of a substantial body of the Greg family own records, mostly now held in the Manchester Archives and the archives held at Quarry Bank Mill.

2.2.3 An updated catalogue is currently being produced for the extensive archive held at the mill, and further details on the development of the site will undoubtedly be provided by future research using this resource. For the present study area, particular use has been made of the archive's memoranda books and mill valuations. The earlier of the two memoranda books seems to have been first compiled in 1881, drawing on sources dating back to 1784, with material being added until 1909. The later book covers the period 1910-25. Both have been consulted through typescript copies of the hand-written originals, and in the case of the earlier book through a partial digital transcript. Parts of the earlier book have also been published (O'Mahony 1989). The information within these memoranda includes building works, alterations to the power system, and changes in the mill's machinery and is particularly detailed for the late nineteenth and twentieth century.

2.2.4 Two valuation books held in the archives stored at Quarry Bank Mill were compiled in 1890 and 1910 for insurance purposes (QBM Memoranda, 155) and provide detailed inventories of the contents of the mill, room by room. A similar valuation of 1923 is held in the Manchester Archives (MA C5/1/1/5). All three of these valuations use the same numbering system for the various buildings within the mill, which is cross-referenced on plans of the same period.

2.2.5 Other material relating to the mill consulted in the Greg muniments in Manchester Archives has included late eighteenth century cash and wages books (MA C5/1/9/1and2, C5/1/1/5/1), early nineteenth century partnership accounts (MA C5/1/2/2-4), and nineteenth century mill ledgers. The collection also contains earlier nineteenth century valuations. One of these was carried out in 1831 by Peter Ewart and John Kennedy after Robert Hyde Greg had questioned the rent which he was charged by his father for his share of the mill (MA C5/1/1/3). A second was compiled in 1834 following the death of Samuel Greg, and there is a third, summary, valuation from 1841 (MA C5/1/1/4, C5/8/31). Documents relating to Quarry Bank Mill held within the Stamford muniments in John Rylands Library have also been consulted, including late eighteenth and early nineteenth century deeds, and two further valuations, of 1845 and 1855.

2.2.6 ***Maps and Plans:*** the exceptional wealth of documentary material for the development of the mill is matched by the surviving body of plans (Fig 3-90). The archive at Quarry Bank Mill holds a collection of original historic plans dating from the 1830s to the 1920s, which include plans of the mill, individual buildings and structural features, and additions and alterations to the power system, together with copies of later surveys and architect's plans, dating from the 1960s onwards. It also holds a copy of the earliest known detailed plan of Quarry Bank Mill, drawn for an insurance policy in 1822 after the mill had undergone considerable expansion (Fig 12).

2.2.7 Detailed Ordnance Survey mapping was made from the 1870s onwards and a series of earlier maps and estate plans also include the mill. These include a survey of the Gregs' Styal estate compiled in 1836 (Fig 3) and a survey of Wilmslow parish by James Cawley in 1840 (Fig 5). Cawley's survey, as well as being used for the tithe award (Fig 4) also served as the basis for later plans of the Gregs' and the Earl of Stamford's Styal estates. These included a plan which accompanied the catalogue for the 1853 sale, and which is expressly said to have been 'taken and enlarged from the Tithe Commutation Map' (JRL EGR 14/17/28/47). The original plan has not been traced but a photocopied section of a plan, showing Quarry Bank Mill and held at the National Trust Office, Altrincham, is probably derived from that source (Fig 6).

2.2.8 In addition to the above, plans and correspondence relating to steam power at Quarry Bank Mill are held within the Boulton and Watt Archive in Birmingham. These were not available for consultation at the time of the present study, but are known, in part through secondary sources and through copies held at Quarry Bank Mill.

2.2.9 It has been hoped to obtain detailed information relating to the later twentieth-century history of the mill, and in particular plans of late twentieth-century alterations to the mill. Despite this request, however, the information has not been forthcoming, and in the present version of the report the later twentieth-century history of the mill is poorly represented.

2.2.10 ***Secondary Sources:*** the wealth of primary material for Quarry Bank Mill means that aspects of the site have been frequently discussed by researchers although, to date, no single detailed study has been dedicated to the development of the building and site as a whole. The most detailed study of the Gregs has been that by Mary Rose, whose accounts are concerned primarily with the development of the family business but also refer to the physical evolution of their mills (1977; 1978; 1986). At an earlier date, Lazenby's work was principally concerned with Styal as an industrial community, and is less informative on the mill itself (Lazenby 1949). An architectural study of some of the main buildings at Quarry Bank Mill by David Lindsay (1963) drew its historical details largely from the Mill Memoranda and Lazenby's work. Lindsay's work was built upon during the East Cheshire Textile Mills Survey, which examined all the standing textile mills in the boroughs of Macclesfield and Congleton during the mid-1980s (Calladine and Fricker 1993). Sources relating to the mill's power system have been discussed in particular by R L Hills (1970; 1989), Nigel Nixon and Josselin Hill (1987), and Jeremy Milln, the latter in connection with a detailed survey of the remains at the north end of the mill (1994; 1995). Sources for the mill's gas plant have been examined by Ian West (2006). Alan Fletcher's account of Quarry Bank Mill between 1939, when it was acquired by the National Trust, and 1978 includes some changes to the fabric (Fletcher 2005). For the period from 1978 to 1993 alterations to the buildings are included in the triennial and quadrennial reports of the Quarry Bank Mill Trust Limited (1980; 1983, 1986; 1989; 1993). Archaeological investigations carried out at Quarry Bank Mill prior to the present work in 2013 are described separately.

2.3 MEASURED SURVEY

2.3.1 ***Introduction:*** the measured survey was carried out to English Heritage Level 3 guidelines (English Heritage 2006b). The external surfaces and two wheel pits were recorded by laser scanning, generating a 3D point cloud which was then used to generate 2D plans, elevations and cross sections. The internal rooms within the building were recorded with a reflectorless total station and the data was used to generate plans and cross sections which were then combined with the laser scan data.

2.3.2 ***Laser Scanning:*** the external surfaces and the wheel pit were surveyed by means of laser scanning. This entailed the automated recording of literally millions of survey points, across the surface of the building, providing an enormous density of 3D points which could then be viewed and manipulated in AutoCAD (using Pointools software). The scanning captured all architectural details (and the stonework surrounding them), including windows, doors, fireplaces, rainwater goods, outlines of brickwork and plaster, the location of fixed machinery, positions of pipework, line shafts, power runs and any significant visible structural cracks.

2.3.3 The survey was undertaken by APR Services Ltd using a Riegl VZ400 laser scanner. The output of the survey is presented as isometric views of the model, as well as 2D slices through the model in order to create plans, cross sections and elevations as required (Figs 91-171). The internal detail of the wheel pit was recorded using a short range Faro Focus scanner. The scan data is provided as pointools POD files.

2.3.4 Horizontal survey control were established by closed traverse and tied into Ordnance Survey co-ordinates using a differential GPS. Vertical control was established using Ordnance Survey Datum.

2.3.5 ***Aerial Photographic Modelling:*** the ground plan of the building was modelled by photogrammetry using aerial photographs taken using an Unmanned Aerial Vehicle (UAV) (Fig 91-4), which is a small remote controlled helicopter with a high resolution camera suspended beneath. Survey control was introduced to the photographs by the placement of survey control targets across the site, which were located by means of survey grade GPS and total station traverse.

2.3.6 Photogrammetric processing was undertaken using Agisoft software which provided detailed modelling using an overlap of up to 90 photographs, and created a very detailed DTM (Digital Terrain Model) across the site. The photographs were then digitally draped over the model to create an accurate three-dimensional photographic texture of the ground surface. The primary output, however, was an accurate two-dimensional orthophoto image that was used to provide plan information, and to generate plans of the topography around the mill complex.

2.3.7 ***Internal survey using conventional survey methods:*** the internal detail was surveyed by conventional survey methods, providing the internal ground plan, and internal cross sections through the structures. This was undertaken by means of a Reflectorless EDM (REDM) instrument survey with respect to survey control established initially by GPS survey, and then extended throughout the interior of the building by closed traverse using the reflectorless instrument. The survey recorded in plan all floors including stairwells, lifts and half floors (Figs 95-133). A series of cross sections were recorded as shown on the drawing provided in the brief, but with the addition of further sections in order to inform the establishment of modifications to the lift tower (Figs 165-171).

2.3.8 ***Control:*** the survey control was established by closed traverse using a Leica TC805 total station, and was located using the Leica 1200 differential GPS, to an accuracy of 0.015m accuracy. Height control was established by the same process.

2.3.9 ***Detail:*** the detail survey was established by REDM instrument, and the data superimposed on the same grid as the laser scan data within a CAD system. The instrument survey was generated by EDM tacheometry using an REDM total station linked to a pen computer running TheoLT software. The digital data was transferred onto the pen computer for manipulation and transfer to other digital or hard mediums. The survey data is accurate to +- 0.01m.

2.3.10 The survey recorded all pertinent archaeological detail. The survey was combined with general topographic mapping of the locale and any other mapping identified during the desk-based study.

2.3.11 The survey produced the following final drawings:

- Scaled plans of all floors of the building showing the location of each element and features of specific architectural and archaeological interest;
- External elevations of the mill (from laser scan data)
- Three cross-sections across the building and one along the long axis of the building, with the addition of a further cross section of the lift turret.

2.3.12 ***Photography:*** in conjunction with the archaeological survey a digital photographic archive was generated, recording significant features as well as general views. A high quality digital SLR camera with 16 megapixel resolution was used to capture general views of the building and its wider context. The internal and external character of the building was then recorded, providing for details including openings, timber framing, assembly marks and other significant features. A metric scale was used for all photographs. All photography was recorded on *pro-forma* sheets showing the subject, orientation and date.

2.3.13 ***Description:*** a detailed description of the complex was carried out to English Heritage Level 3 guidelines as appropriate, utilising *pro-forma* sheets. This provided a comprehensive analytical account of the buildings special importance using the following methodology.

2.3.14 The written account places the buildings in their historical, architectural and cultural context and includes accounts of the following:

- A general description of the buildings, including details of their plan, form and function. Allied to this, a detailed description of the materials used is provided alongside a description of the development sequence and phasing, including any evidence of alterations, repair and rebuilding.
- An account of the wider context within which the buildings are situated. For example, its relationship to places and buildings within the local area, as well as its historical relationship to the area;
- An appropriate description of each individual room/ discrete space and component.

2.4 ARCHIVE

2.4.1 A full professional archive has been compiled in accordance with the project design (OA North 2012), and in accordance with current IfA and English Heritage guidelines (English Heritage 2006a). The paper and digital archive will be deposited with the National Trust on completion of the project.

3. HISTORICAL BACKGROUND

3.1 OWNERS AND OCCUPANTS

3.1.1 ***Samuel Greg (1784 to 1832):*** Samuel Greg, born in Belfast in 1758, was the son of a leading merchant and ship owner. From the age of eight he was brought up by his uncle Robert Hyde, a Manchester textile merchant and manufacturer. On completing his education Samuel first became an apprentice and then a junior partner in Hyde and Company and, in 1782, following the death of Robert Hyde and the retirement of Robert's brother Nathaniel, he took over the firm. In the early 1780s the Hydes also became factory owners by building a hand-weaving shed at Eyam in Derbyshire. Quarry Bank Mill is reported to have been built originally to supply this with yarn (Rose 1986, 15-16, 18).

3.1.2 The land on which the mill was built was leased by Samuel Greg from the 5th Earl of Stamford in January 1784, with the mill being completed later that same year (*Section 3.3.1-2*). Greg's intention was for the mill to be run by John Massey, who provided the technical expertise and was taken into partnership, but in 1784 Massey died before the mill began operation. Instead, for the next 12 years, it was run on Greg's behalf by a manager, Matthew Fawkner (Rose 1986, 19-20). In 1789 Samuel married Hannah Lightbody, the daughter of a Liverpool merchant. During the 1790s the Gregs and their children occupied a town house at 35 King Street in Manchester, but used Oak Farm in Styal as a summer retreat (Matrix Archaeology 2007, 4).

3.1.3 In 1796 Greg embarked on a programme of expansion at the mill with the assistance of the millwright Peter Ewart, who now became a partner in the business. Ewart had formerly acted as the Manchester agent for Boulton and Watt and in 1793-4 had briefly been in partnership with Samuel Oldknow, the owner of mills in Stockport and Mellor (Hills 1989). Following this expansion at Quarry Bank Mill, the Gregs moved to Quarry Bank House. An entry in the diary of Hannah Greg implies that this was originally built in 1798, as a new summer residence. The house was at first a relatively modest dwelling but was remodelled and more than doubled in size, in, or shortly before, 1803, to create a more fitting permanent residence (QBM Memoranda, 3).

3.1.4 Quarry Bank Mill was an Arkwright-type factory, designed to produce coarse warps using water frames. From an early stage Samuel Greg also appears to have been using mules (*Appendix 1*), capable of producing finer yarn, and in 1807 he and Ewart built a mule-spinning mill at Peter Street in Manchester (MA C5/1/2/2; Rose 1977, 154-5; 1986, 22). It is unclear where the firm's mule spinning was taking place prior to that date, but during this earlier period some weft was produced for Greg at a small mill in Wilmslow run by William Bower, and Greg also rented his own spinning shop in the town (QBM Memoranda, 40). It was also around 1807 that the weaving shed at Eyam ceased operation, with the firm now concentrating on spinning (Rose 1986, 22).

3.1.5 Peter Ewart seems to have increasingly turned his attention to the Peter Street Mill. From 1811 he was only a sleeping partner at Quarry Bank Mill, and in 1815 he retired altogether from his partnership with Samuel Greg and purchased the Manchester mill (*op cit*, 37-8; QBM Memoranda, 3). Quarry Bank Mill continued to produce low counts of yarn throughout the nineteenth and into the twentieth century, and when weaving was introduced this was of coarse calicos (Rose 1977, 156).

3.1.6 After the separation from Peter Ewart, Samuel Greg began to expand his own business. Quarry Bank Mill was enlarged between *c* 1817 and 1820, (*Section 3.3.4*), and other mills were now acquired. The first was Low Mill at Caton near Lancaster, which passed to Greg in 1817 in lieu of trading losses occurred by his nephew-in-law Isaac Hodgson. Over the next 14 years this small water-powered mill was enlarged, and the power system was upgraded with a waterwheel by Thomas Hewes and a 20hp steam engine by Boulton and Watt. It was worked in tandem with Moor Lane Mill in Lancaster, a steam-powered site which Greg bought in 1823 and extended in 1825-6. This was a combined mill, carrying out both weaving and spinning, and in 1832 was the largest of the firm's concerns. Hudcar Mill in Bury, a large combined mill, was purchased by Greg in 1827. In 1832 he leased Lowerhouse Mill, in Bollington, which the firm also operated as a combined concern. As a result of this expansion, between 1816 and 1833, Samuel Greg and Co developed into one of the largest spinning and weaving businesses in the country, with a tenfold increase in the workforce to over 2000 (Rose 1977, 30; 1986, 38-40).

3.1.7 During the same period, Samuel brought his younger four sons into the firm: Robert Hyde Greg in 1817; John Greg in 1824; Samuel Greg junior in 1827; and William Rathbone Greg in 1830. The eldest son Thomas Tylston had no involvement in the business as his uncle had made him his heir. Each of the four were involved in the running of the firm's mills, under the overall control of their father until his retirement in 1832. Robert Hyde Greg concentrated on Quarry Bank Mill, and built the nearby Norcliffe Hall as his residence in about 1830. He was also involved in the Manchester mercantile side of the firm. John ran the mills at Lancaster and Caton, Samuel junior worked with Robert Hyde at Styal before moving to Bollington, and William Rathbone was assigned to the Bury mill. The profits of the business were shared between them, proportionate to age and experience. In 1831 Robert Hyde received 25%, John 15%, and Samuel junior and William 10% each. Samuel Greg took the remaining 40%, and also charged his sons a rent for their mills and machinery (Rose 1978, 12; 1986, 49).

3.1.8 ***Robert Hyde Greg (1832 to 1870):*** after the retirement of Samuel Greg in 1832, the partnership between the sons continued for nearly a decade, with Robert Hyde Greg in the leading role. In the late 1820s and 1830s the profitability of Quarry Bank Mill decreased as a result of its specialisation in spinning in a period of falling yarn prices. There had been a brief experiment in powerloom weaving at the mill in the early 1820s, involving no more than half a dozen looms (QBM Memoranda, 43; MA C5/1/4/2).

3.1.9 Robert Hyde Greg added weaving to the mill on a permanent basis in 1836-8. Powerlooms were also installed at the Caton mill when this was partially rebuilt by John Greg following a fire in 1837 (*Preston Chronicle*, 15 July

1837). At Bollington and Bury, Samuel junior and William Rathbone were proving less adept at mill management and in 1841 the partnership between the four brothers was dissolved, with each taking the mill for which he had been responsible. The Manchester marketing business was run by the partnership until 1844, when Robert Hyde Greg took control (Rose 1986, 63-5). However, the products of the Gregs' various mills continued to be sold through that business into the twentieth century (Rose 1977, 23). Of Robert Hyde Greg's brothers, Samuel retired from the textile business in 1847. William Rathbone then stepped in to run Lowerhouse Mill but in 1850, when his brother John sought to take it over, William himself retired, selling his Bury mill in the process. In 1864 John sold the Caton and Lancaster mills, and Lowerhouse Mill was converted to a limited company by his sons (Rose 1986, 66-7).

3.1.10 Robert Hyde Greg, who operated Quarry Bank Mill under the name of R H Greg and Co, expanded his interests by acquiring other mills. However, he organised his empire differently to his father, with separate partnerships for each of his mills, and for the Manchester mercantile business. In 1847 he leased Calver Mill in Derbyshire, a spinning and doubling mill which was run by his eldest son, Robert Philips Greg. This arrangement was not a success and the mill was given up in 1864 (Rose 1977, 22; 1986, 67-8, 70). From 1845 Robert Hyde and his brother John began to develop an estate in Reddish, originally acquired by their father, by building two spinning and doubling mills next to the Stockport branch of the Ashton Canal. The intention was for both mills, named the Victoria and the Albert, to be leased out, but when the business at the Albert Mill soon failed Robert Hyde took this over in partnership with David Bowlas, the lessee of the Victoria Mill. The Albert Mill was extended immediately, doubling its size, so that in 1853, when Robert Hyde and his third son Henry Russell Greg assumed full control, it was a larger concern than Quarry Bank Mill (Rose 1986, 68; Arrowsmith 1997, 219). The Albert Mill descended subsequently through Henry Russell's family and was greatly extended in the early twentieth century, when it came to specialise in the production of fancy yarns. It finally closed in the 1960s, and was the last of the Gregs' mills to be in operation (O'Connell 1988).

3.1.11 As well as being involved respectively with Calver Mill and the Albert Mill, both Robert Philips and Henry Russell became partners in the Manchester marketing firm, renamed Greg Brothers in 1866, when their father gave up this part of his business (Rose 1977, Appendix B). Robert Hyde's second son, Edward Hyde Greg, was taken into partnership at Quarry Bank Mill in 1850 and assumed sole control of the mill in 1870, when his father finally retired at the age of 75 (Rose 1978, 19).

3.1.12 It was during Robert Hyde Greg's period in charge of Quarry Bank Mill that the lands at Styal, which the family had previously leased from the Earls of Stamford, became their own property. Samuel Greg had purchased Oak Farm from the fifth Earl in 1802. In 1829, encouraged by his son Robert Hyde, he had considered buying the remainder of the estate but believed that the cost would be too great a burden (Rose 1986, 25, 52).

3.1.13 In September 1853 the Stamford estate, within the parish of Wilmslow, was put up for auction by the 7th Earl. Although a sales catalogue was advertised

ahead of this event (JRL EGR 14/17/28/58), no copy of this has been traced. Other records of this period list Quarry Bank Mill as lot 88a (JRL EGR 14/17/28/76 and 77). If it was actually included in the 1853 auction, then, like a number of other lots, it failed to find a buyer at that time. In 1855 Robert Hyde Greg purchased the mill and other land on the Earl's Styal estate, using money from the sale of land in Norfolk which he had inherited from this father and uncle (Rose 1977, 244-5, 260-1, 326). On Robert Hyde's death in 1875, his Styal estate was divided between his three younger sons, with Edward Hyde Greg obtaining the largest share, 330 acres, including Quarry Bank Mill, Norcliffe Hall and Quarry Bank House. Henry Russell Greg, who ran the Reddish mill, received 200 acres, including a house at Lode Hill built as his residence in the 1860s, while the remaining 34 acres passed to the youngest brother, Arthur Greg (Rose 1978, 30).

3.1.14 ***Edward Hyde Greg to Closure (1870 to 1959):*** Edward Hyde Greg, Robert Hyde's successor at Quarry Bank, ran the mill from 1870 to 1900. During this period it suffered a sharp decline. Rose notes how as '*an old rural mill producing coarse yarns and cloth, it was particularly vulnerable to the ravages of foreign competition. Orders and scale declined and short time working became normal*'. From 1880 to 1899 the mill was running at an average annual loss of £768. In the late 1880s and early 1890s ring-spinning frames were installed but seem to have had little impact on efficiency. In 1894 spinning at Quarry Bank ceased. From then until its closure the mill was used only for weaving (Rose 1986, 91-2).

3.1.15 Like his father and grandfather, Edward Hyde Greg also had business interests which extended beyond Quarry Bank Mill. In 1879 he became a partner in Greg Brothers. In 1870 the firm had diversified its own activities by taking over the Cast Metal Mill, a spinning and doubling mill in Stockport, and in 1881, Greg Brothers became the managing directors of Cressbrook Mill in Derbyshire. Neither venture was a financial success (Rose 1986, 100).

3.1.16 ***Robert Alexander Greg (1900 to 1939):*** Robert Alexander Greg, Edward Hyde's son, took over Quarry Bank Mill in 1900 and increased productivity at the mill by the introduction of Northrop automatic looms in 1909 (Rose 1986, 95-7). Until 1905 Robert Alexander was also managing director of the limited company of Samuel Greg and Co which ran the Lowerhouse Mill until 1905, when this mill was leased to its former manager (QBM Memoranda, typescript copy, 210). During his ownership of Quarry Bank, in late 1919, the mill was put up for sale, but, although offers were made, all were thought to be too low (QBM Memoranda 1910-25, typescript copy, 68).

3.1.17 In 1923 the business was made into a limited private company, under the name of the Quarry Bank Mill Co Ltd. While Robert Alexander and his brother Ernest were the principal shareholders, its management was designated to an existing employee, accountant Samuel Henshall who remained in charge until the mill's closure. In the late 1930s, with the weaving of coarse cloth no longer financially viable, he modified the looms and shifted production to the manufacture of laundry bags (Rose 1986, 140-1; Fletcher 2005, 11-2).

3.1.18 Robert Alexander Greg was childless, and the two eldest sons of his brother Ernest were killed in the First World War. In 1939 the third son, Alexander,

donated a large part of the estate, including Quarry Bank Mill, to the National Trust (Rose 1986, 138-42).

3.1.19 ***1939 to present:*** the Second World War years saw R Greg and Co, as the firm was renamed in 1939, suffer a reduction in the size of the labour force, which fell from 178 in the 1930s to 13 in 1950. The business never recovered from this decline and production ceased in 1959, by which time there were only six employees. In the following year the last of the firm's machines were sold for scrap (Rose 1986, 140-1; Fletcher 2005, 77-8). Henshall continued at the mill as employee of the National Trust until his retirement in 1964 (Fletcher 2005, 14-5).

3.1.20 As the business contracted other tenants moved into the mill. During the war, parts were rented by several businesses as storage, and two rooms were used by the Wilmslow Rifle Club. After the war other businesses leased space for manufacturing or as workshops, continuing after the demise of R Greg and Co (Fletcher 2005, 64-72).

3.1.21 By the late 1960s Quarry Bank Mill faced dereliction, and between 1968 and 1976 over £240,000 was spent on its repair (Fletcher 2005, 103-5). In 1976 the Quarry Bank Mill Trust Limited, an independent charitable trust, was set up with the aim of opening the mill as an industrial museum and leased the buildings from the National Trust. The first room was opened to the public in 1978.

3.1.22 The majority of commercial tenants had quit the mill by the early 1970s, leaving only the Styal Engineering Co. This ceased business in 1978, immediately prior to the opening of the museum, and the firm's staff, under Mr F Madders, then became the Quarry Bank Mill Trust's engineering unit (Fletcher 2005, 64, 71-2). The Styal Engineering Co, however, was not the last commercial tenant. In 1975 a small weaving unit opened on the ground floor of the former large weaving building, now the restaurant. It was run by Greg Bros Ltd, the Greg family's old marketing firm, but ceased operation in 1979 (Fletcher 2005, 74-5).

3.1.23 In 1984, 200 years after it had been first built as a cotton factory, Quarry Bank Mill won the Museum of the Year Award (Rose 1986, 142). In 2000-1 the National Trust took over responsibility for the running of the site (Janes 2010, 109).

3.2 PRE-1784 DEVELOPMENT

3.2.1 It is generally accepted that the overriding factor behind the siting of Quarry Bank Mill in a relatively isolated spot away from the main local centres of population, was the opportunity for water power provided by the River Bollin. This potential was confirmed by the surveyor Hugh Oldham, who reported in August 1783 that from 'Pownall Ford' there was a fall of water of 14ft 2¾in, considered sufficient to provide power to the mill (Lazenby 1949, 30).

3.2.2 The original lease which Samuel Greg and his short-lived partner John Massey obtained for the site from the landowner, the Earl of Stamford, does not appear to have survived, but, according to the Mill Memoranda, it appeared to be dated to January 1784 (QBM Memoranda, 1). A new lease, for 21 years, was

granted in 1791 (JRL EGR/14/6/3/6) and although this document is extant it is in a poor condition and cannot now be consulted (JRL EGR/14/2/13/6). However, it was in turn superseded in 1798 by a lease for the lives of Samuel Greg, his son Robert Hyde Greg and partner Peter Ewart. The land which this lease encompassed comprised the Lower Bridge Field, the west side of the Great Sand Field, the nearer Cowhey, the Long Bottom, the Little Orchard, in total amounting to 6 acres 2 roods 36 perches of the Cheshire measure, and the Quarrel Hole, amounting to 1a and described as adjacent to the mill weir (JRULM EGR 14/3/10/40) This first weir was built in 1784 and is shown on a plan of *c* 1796-1801, held in the archive at Quarry Bank Mill and was attributed to Peter Ewart; it lay on a bend in the river *c* 0.5km upstream of the present weir (Matrix Archaeology 2010, figs 2 and 19). It provided the original supply of water for the mill, but was not capable of driving the enlarged mill planned by Samuel Greg, and a new weir was then constructed in the period 1796-1801 (*op cit*, figs 2 and 20) and was located 120m upstream of the mill, entailing the modification of the head race.

3.2.3 The Quarrel Hole referred to in this lease should not be confused with the rock cut chamber on the west side of Ewart's weir, known at the 'Kirk Hole' or 'Disley Kirk', which was adopted to hold sluice gear. In a later lease of 1835 the same land was listed as including Lower Bridge Field or Ferney Brow, the Great Sand Field or High Field, the nearer Cowhey or Clover Field, and the Quarry Hole or Stonepitt Bottom (JRULM EGR 14/3/10/41). From a Greg estate survey compiled in 1836, this land can be seen to have extended alongside the Bollin from the site of Samuel Greg's original weir of 1784 to the site of the mill and Quarry Bank House (OS plan of 1872-6; MA C5/7, C5/6/2; Fig 3) which was 0.5km south of the mill (Matrix Archaeology 2010, fig 19.

3.2.4 While the first lease to Samuel Greg is lost, there is a surviving surrender of a lease which provides details of the previous occupancy of the mill site. By this document, dated 3 January 1784, Hardey Leather, yeoman of Hale, relinquished to the Earl of Stamford land by the Bollin at Styal, comprising the Lower Bridge Field, the west part of the Great Sand Field, the Lower Cowhay, the Long Bottom and the Little Orchard, amounting to 6a 2r 36p. Leather held this land under a lease for life given in 1768, and at the time of its surrender it was occupied by George Shaw as undertenant (JRL EGR/14/2/13/6). It is clear that prior to 1784 this land formed part of the tenement of Cross Farm/ Shaws Fold. The estate survey of 1836 shows this tenement abutting the land surrendered by Hardey Leather, while a valuation of 1797 describes the tenement as 'late Hardey Leather' and lists the farm buildings as being 'held by George Shaw' (JRL EGR/14/7/25).

3.2.5 The site chosen for the actual mill formed part of the Lower Bridge Field, as noted in the 1798 lease which described it as '*that factory warehouse edifice and building lately erected and built and now standing on said close called the Bridge Field*' (JRULM EGR 14/3/10/40 and 41). The structure which gave this field its name may have been the predecessor of the present stone bridge which crosses the Bollin at the north end of the mill. The Mill Memoranda records that this stone bridge was built in 1820 and replaced '*a wooden foot bridge within a short distance of where the bridge was erected*'. It also reports that a bridle road from Morley crossed the river upstream of the mill, by a ford

near the original weir, and ran along the east bank on a line later occupied by the mill's weaving shed and blowing room (QBM Memoranda, 35-6).

3.3 1784-96 – THE FIRST PHASE OF MILL CONSTRUCTION

3.3.1 Although Samuel Greg first gained the tenancy of the site in January 1784, preparations for the construction of the mill were already underway. An account survives for timbers bought by Greg from Samuel Taylor and Co, which were evidently for the new mill. A small part of this timber was purchased as early as September 1783, followed by a much larger quantity in November/ December 1783. The accounts also include payment for a further substantial quantity in July 1784, including 612 feet of oak planks (QBM A122). Work on the building must have been effectively complete by 1 September 1784, when the mill was described as '*equipped with machines and devices for carding, roving, spinning and manufacturing cotton and cotton material*' (QBM A122) (*Appendix 1*).

3.3.2 Documentary evidence for the internal arrangement of the original mill is slight. Cash books and a wage book for the late 1780s and the 1790s list the '*spinning room*', '*carding room*' and '*reeling room*', but also refer to the first two of these, and occasionally the third, in the plural. There is also mention of the '*making up room*' (MA C5/1/15/1; C5/1/9/1 and 2). In 1796 the spindleage totalled 2425 spindles (Rose 1986, 20), but this was seemingly before the mill was extended. Samuel Finney of Fulshaw Hall in about 1785 described the mill as containing about '*three thousand spindles*' (Lazenby 1949, 21).

3.3.3 No documentary evidence for the stair tower of the 1784 mill has been found before the early nineteenth century, although from the physical evidence it has been concluded that it was probably contemporary with the mill's construction (Milln 1995, 13). The stairs were originally of wood as noted on the 1822 insurance plan (Fig 12). By this date they had already undergone some modification, since a mill ledger notes '*New Steps in the Mill staircase April 20th 1817. Three of the bottom steps paved with Iron*'. The ledger adds that '*The above named staircase was taken down May 1828 and a new Brick staircase and Flag Steps put in its stead*' (MA C5/3/1). In the 1840s the ground-floor room of the stair tower was described as a lodge (EGR 14/17/23; Fig 42). The earliest known historical evidence for the privy tower of the 1784 mill is provided by the 1822 insurance plan, but from the physical evidence this has been identified as an original feature (Milln 1995, 13).

3.3.4 In 1792, after only eight year's of operation, the mill's waterwheel was evidently replaced (Rose 1986, 20; Hills 1970, 106). The evidence for this is provided by a cash book, which on the 19 May 1792 recorded '*Exp[ence]s for New Wheel*', 6s, followed on the 7th July by an outlay of £6 16s 11d for '*Car[riage] etc of Water Wheel*' (MA C5/1/9/2). No documentary evidence has been found relating to the horse power of the waterwheel at the mill during this early period, either for the original wheel or its 1792 replacement. However, in the case of Arkwright-type water frames, 100 spindles were reckoned to require roughly 1 nominal hp (Tann 1970, 29), implying that in 1796 the waterwheel was able to provide approximately 25 nominal hp.

3.4 1796-1817 – THE FIRST EXTENSION

3.4.1 The first extension of the mill is recorded under the year 1796 in the Mill Memoranda, which notes that, following the arrival of Peter Ewart, '*An enlargement of the Mill took place, an addition to the South end and raising of the roof and attics, and a 2nd water wheel of iron, the first one ever attempted*' (QBM Memoranda, 3). The 1784 mill and its 1796 extension were later together known as the Old Mill, to distinguish them from the New Mill which was added to their south end in 1818-9.

3.4.2 The addition of the 1796 extension was followed by a rise of spindleage, which by 1818 was roughly double that in 1796 (*Appendix 2, Table 1*). Entries in a mill ledger for 1811, 1814 and 1818, show that these spindles were divided between the 1st and the 2nd Spinning Room (MA C5/3/1; Table 6), and in 1818 the same source refers to a new drawing frame in the Top Card Room. Evidently two of the four main floors of the Old Mill, excluding the basement and attic, were used for spinning during this period, with carding (*Appendix 1*) and other preparation taking place in the other two.

3.4.3 The earliest known datable historical evidence for the privy tower and hoist on the west wall of the 1796 mill is again provided by the 1822 plan (Fig 12). A contemporary cash book confirms the installation of a new waterwheel in the spring of 1796, recording the cost of ale provided to men working in the cut and tunnel, both presumably references to a new section of race dug for this wheel, as well as on the waterwheel itself (Table 1). In July there were payments in connection with new shafting and gearing (*ibid*). No evidence has been found to confirm that this wheel was of iron, and there may be confusion here with a replacement waterwheel installed a few years later (*Section 3.4.4*). What does seem clear is that the waterwheel installed in 1796 supplemented rather than replaced the earlier power system. The reference in a 1798 Stamford lease of the mill to 'waterwheels' is possibly a legal generalisation (JRL EGR 14/3/10/40), but a partnership book provides unequivocal evidence for two waterwheels in operation, with an entry for 1 March 1801 recording £250 as the '*Cost of Work connecting the 2 Water Wheels Iron Pillars andc*' (MA C5/1/2/2). The relatively high figure suggests that the last reference is to the insertion of iron columns to support the mill floors. These are first firmly documented on the 1822 insurance plan which describes the Old Mill as containing 'Iron pillars supporting each room' (Fig 12, A).

3.4.4 The present weir (NT SMR 57182), which is 120m upstream of the mill (Matrix Archaeology 2010, Fig 20), was built between 1796-1801 to increase the supply of water to the mill. It replaced the earlier 1784 weir, and in so doing created a broad body of water covering over five acres which extended back to the site of the original weir, suggesting it purely increased the volume of water stored, rather than raising the head of water to the wheel. The undated plan that shows the site of the proposed pond or 'mill dam' is attributed to Peter Ewart (*op cit*, fig 2), but the construction works seem to have followed on from the extension to the mill and the installation of the second waterwheel. A partnership book lists payments for the new weir in 1799 and 1801 (MA C5/1/2/2). The Mill Memoranda records its construction under the years 1800-1, along with the installation of the mill's first steam engine: '*The first Engine*

10 horse (nominal) was put up. The stone weir and Mill dam made' (QBM Memoranda, 3).

3.4.5 This dating of the introduction of steam power is questionable. Jeremy Milln has argued that the likely source of an engine at this date would have been Boulton and Watt, given Peter Ewart's former employment with the firm, but no reference for such an engine is known within the Boulton and Watt Archive in Birmingham. The archive does contain drawings for an engine for 'Greg Manchester', dated 1802, which from correspondence seems to have been built. However, this was a 30hp house-built engine, and the drawings are said to be incompatible with the physical evidence at Styal (Milln 1995, 13). The horse power is relatively high for this period and suggests a solely steam-powered mill, but the date seems too early for this to be Greg and Ewart's mule-spinning (*Appendix 1*) mill on Peter Street in Manchester.

3.4.6 Perhaps more crucially, the partnership book for Quarry Bank Mill includes no expenditure on a steam engine in the early 1800s. Rose has suggested that a steam engine was installed as early as 1796 (Rose 1978, 9), but this does not appear to have gained any acceptance. The cash book for 1796 records money for ale for the men '*finishing New Engine*' (Table 1). The reference might conceivably have been to a short-lived steam engine in use prior to construction of the mill dam, but is perhaps more likely to relate to some other machinery, such as carding engines.

3.4.7 An entry in the partnership book for 1 Sept 1806 records '*Cost of Steam Apparatus*' £200 (MA C5/1/2/2). This is probably the source of the modern claim that the original steam engine at the mill was replaced in 1806 (Rose 1978, 9; Nixon and Hill 1987, 3). However, the reference may be not to steam power but to steam-heating apparatus, since entries in the partnership book on 1 May 1807 imply that such a system was then being extended to include a newly built warehouse: '*1/3 cost of sheeting the Mill floor*' £50, '*cost of new warehouse Sheeting floors and Steam pipes*' £370 (MA C5/1/2/2). An undated plan of the Old Mill shows five vertical '*steam pipes*' arranged along the mill body (Fig 13), and the Mill Memoranda records that until 1880 the mill was heated with low-pressure pipes, which '*had long been considered a slow and expensive method*' (QBM Memoranda,119). The covering of the mill floors with iron sheeting, as a form of fireproofing, is also documented on the insurance plan of 1822, which describes the Old Mill as having '*wooden floors, cased with sheet iron' (*Fig 12, A).

3.4.8 There is clear documentary evidence that in 1807 one of the two waterwheels was replaced. Both Samuel Greg's personal ledger and the partnership book include an entry for 1 March 1807 recording '*Cost of New Water Wheel and Tunnel*' £800, '*d of Alteration in Mill Gear*' £40, '*deduct value of Old Wheel*' £220 (MA C5/1/1/1; C5/1/2/2). The installation of a new waterwheel at this time is not noted by the Mill Memoranda, and this may well be the iron wheel which is dated by that source to 1796. Furthermore, as Hills and others have concluded, it is likely that the wheel installed in 1807 was built by Thomas Hewes, a pioneer of the suspension wheel, who, in *c* 1818-9, built the great waterwheel at the mill. A surviving mill ledger includes a transcript of instructions given by Hewes in September 1815 for the repair of a waterwheel at Quarry Bank Mill (MA C5/3/1).

3.4.9 These instructions show that this was a suspension-type wheel, built primarily of iron, and partly of wood, with gearing to the rim, this gearing being probably of the external variety (Smith 1969, A87-89; Hills 1970, 107; Hills 1989, 37; Nixon and Hill 1987, 26-7). Suspension wheels appear to have been first developed in the 1800s, making this wheel at Quarry Bank Mill one of the earliest known examples (Hills 1989, 37). Plans of 1834 and others undated show the upright shaft of the Old Mill positioned in the sixth bay from the south end (Figs 13, 17-19, 26, 27), *ie* where the 1784 mill was joined by the 1796 extension.

3.4.10 The first steam engine known for certain to have been installed in the mill was acquired in 1810 from Boulton and Watt. Ewart wrote to them in February of that year, asking to jump the queue by having an engine which had been ordered by the engineer John Rennie. Ewart also requested that the boiler should be '*about 3 feet longer than the usual dimensions, for although we are not likely to want the engine in winter, yet we may have occasion to use it when we want to warm the mill with the same boiler*' – further evidence for an early steam-heating system at the mill. Rennie's permission was given in April, when Ewart sent to Boulton and Watt a sketch revising the arrangement of the engine and boiler, with the explanation that '*the water course for one of our water wheels passes under the place where we first proposed to place the engine and having some doubt about the strength of the arch we have now decided to place the engine as above*'. The parts arrived in May and were erected 12 days later. On 19th May Ewart wrote to James Watt junior, '*It works very well and I beg you to accept Mr Greg's and my best thanks for your dispatch and friendly attention to our wants. On the very day we got it to work we had a plentiful fall of rain and we have not since been short of water – had the dry weather continued however, we should have derived much benefit from the engine*'. This was not a conventional beam engine, but was a 10hp, side-lever independent engine, originally intended for a mud barge (Hills 1988-9, 37-38; Milln 1995, 13, both citing material in the Boulton and Watt Archive). The expenditure for the new engine and boiler features in the accounts of the following year, 1811 (MA C5/1/1; C5/1/2/2; C5/1/2/3).

3.4.11 As shown on the 1822 insurance plan, the house for the 1810 engine was located against the northern end of the west wall of the Old Mill, enclosing the privy tower on this elevation (Fig 12, E; Fig 174. The plan describes this as simply an '*Engine House one story high containing 10 horse Engine*', but the boiler was also housed here. Its chimney, shown on the 1822 plan, was built in the angle formed by the mill wall and the north side of the privy tower, and the location of the boiler in this area is confirmed by the Mill Memoranda which records that '*The first Engine together with its Boiler stood near where the old chimney stands*' (QBM Memoranda, 53) (Fig 174).

3.4.12 Ewart's sketch of April 1810 (*see below*) shows a separate boiler house and engine house with the privy tower in between (Milln 1995, 15). When construction began, however, the engine and boiler were accommodated within a single elongated house, shown on the 1822 plan (Fig 12). This also appears on a plan of June 1834, with the part to the north of the privy tower identified as the boiler house (Figs 14 and 174).

3.4.13 Details of the boiler are given in a mill ledger entry of 7th November 1835: *'Dimensions of Boiler as taken by Mr Ewart's engineer. 12ft long, 4 ft wide, 5ft 4in deep. Feed pipe 6ft long. Fire place 5ft long, 3ft wide. Flues 3ft 6in high and 11in wide. Would drive 15 Horses'* (MA C5/3/1). Ewart's original sketch for the engine shows the flywheel shaft extending into the mill to link with the upright shaft powered by the northern waterwheel. As noted above, his modified plan of April 1810 repositioned the engine in relation to the tailrace from the waterwheel, but the detailed survey of the mill by Milln (1995, 15) revealed that the chimney was built directly on the tailrace vault.

3.4.14 The tailrace discharged into the Bollin through an arch which was built as part of a retaining wall to the river and which bears the date of 1810, leading Hill to suggest that the retaining wall was added to create extra space for access to the engine (Hill 1970, 107). In fact, other evidence suggests that from 1810 another building stood between the engine and boiler house and the river, and is shown on the 1822 insurance plan as a single-storey range, described as a '*Cleaning Cotton room*' (Fig 12, G; Fig 174 building 2). Its west wall was set back from the river's edge, while on the east the building abutted the engine and boiler house and, on the south-east, the west wall of the Old Mill.

3.4.15 The same building is shown, unnamed, on the plan of June 1834 (Fig 14), and is identified again as containing a scutching, or cotton cleaning, room on a plan of July that year (Figs 16 and 174). A valuation of the mill made for rating purposes in October 1810 describes the engine house as having an area of 176 sq yds (Table 2). This figure greatly exceeded the area of the engine and boiler house, but might be explicable if it included the scutching room.

3.4.16 Between 1796 and 1817 other ancillary buildings were added to the mill. The Mill Memoranda records under the year 1803 '*New stables built for the house and mill, and a little before, enlargements of Quarry Bank house*' (QBM Memoranda, 3) (Fig 174). The valuation of 1810 also lists stables, but gives their area as 194 sq yds (Table 2). This is somewhat larger than the present structure (which in its present extent is 170 sq yds) to the south-east of the main mill buildings, and if correct may suggest that it corresponds with an alternative building. However, given that the stables to the south-east of the mill (Fig 174 (Building 7)) appears from at least 1936 in this location there is the possibility that this is a reference to the construction of the present stables and the size estimate is inaccurate.

3.4.17 Although the Mill Memoranda describes the stables as serving both Quarry Bank House and the mill, it later records that prior to 1877 the carriage of goods and materials to and from the mill was undertaken by local farmers (QBM Memoranda, 109-10). Other evidence seems to confirm that in the mid-nineteenth century the stables were reserved for Quarry Bank House. A Stamford terrier of *c* 1853 records that both the house and the stables, which are listed there as 'outbuildings', were leased by Robert Hyde Greg but occupied by Miss Agnes Greg (JRL EGR 14/6/3/10, nos 195 and 216). She was an unmarried daughter of Samuel Greg, who lived at the house after his death (EGR 14/3/10/41). In a Stamford survey of 1845, which also includes 'Miss Greg's Residence', the stable building is listed as a 'Coach House' (JRL EGR 14/7/23). A subsequent survey, of 1855, describes it as 'Coach and Stables 2 stories', with an area of $116^{1}/9$ sq yds (JRL EGR 14/17/28/83).

3.4.18 The partnership book (*Section 3.5.4*) records a 'new warehouse' in 1807, and the 1810 valuation also includes a warehouse, with an area of 96 sq yds, as well as 'workshops' with an area of 59 sq yds (Table 2). A cotton warehouse is known to have stood to the south-west of the Old Mill. It was taken down *c* 1837 to make way for a weaving shed (QBM Memoranda, 55) (Fig 174 Building 5), but is shown on plans of 1834-6, with a footprint of roughly the same area as that given in the 1810 valuation (Figs 16, 23, 34). The valuation of the mill carried out in 1831 gives the floor area of the cotton warehouse as 186 sq yds, implying that it contained an upper and lower storey (Table 4). The location of the workshops listed in 1810 is uncertain, but its area suggests that these formed the western part of the workshops and office range still standing to the south of the main mill buildings (see further below) (Fig 174).

3.4.19 The lease of 1798 included, in addition to the mill, '*all those five messuages or dwellinghouses and all other the edifices and buildings also lately erected and built upon the said close called the Bridge Field and now in the several possessions and occupations of the said Samuel Greg and Matthew Faulker [blank left] Kendall and other servants and workmen of the said Samuel Greg*' (JRL EGR14/3/10/40). One of these five dwellings may have been Quarry Bank House. The locations of the others, which from the description seem to have been workers' houses situated on or close to the mill site, are unknown.

3.5 1817-36 – A MAJOR PERIOD OF EXPANSION

3.5.1 The mill underwent substantial expansion in the late 1810s. The New Mill was constructed at the south end of the 1784 / 1796 range (the Old Mill) and was equipped with the largest of the mill's waterwheels. This was a suspension wheel built by Thomas Hewes of Manchester, who also installed the gearing for the New Mill (QBM Mill Memoranda, 4, 37-8; Smith 1969, A90-91). As noted above, Hewes had advised on the repair of an earlier wheel at Quarry Bank Mill in 1815, which he himself had very likely built in 1807. The Mill Memoranda and other documents show that the firm, which he founded, continued to be employed as millwrights at the mill until the 1900s, installing and repairing gearing, advising on improvements to the power system, and, in the 1830s and 1840s, liasing on the Gregs' behalf with Boulton and Watt. In the 1820s Hewes worked in partnership Henry Wren, and, after Hewes's death in 1832, the firm continued as Wren and Bennett, and from 1851 as Wren and Hopkinson (http://www.gracesguide.co.uk). Jennifer Tann has written that '*the partnership of Hewes and Wren and later of Wren and Bennett marked the zenith of the millwrighting trade*' (Tann 1970, 103). In the 1810s William Fairbairn, whose reputation in Tann's view has overshadowed this firm, was himself briefly an employee of Thomas Hewes.

3.5.2 Hewes' waterwheel for the New Mill at Quarry Bank Mill was 32ft in diameter and 21ft wide, and in 1847-9 was estimated at 100hp (MA C5/6/5). Earlier estimates were of 90hp (MA C5/8/13/2; PP 1834 XX, D1, p 301, no 238). To allow a wheelpit of sufficient depth to be constructed, a tailrace tunnel was dug which discharged into the river at the Giant's Castle, at a distance of *c* 1km from the mill. Water was supplied from the same headrace that fed the earlier wheels within the Old Mill.

3.5.3 A partnership book includes expenditure on the tunnel from 1817, on the New Mill from 1818 and on the new waterwheel from 1819 (MA C5/1/2/3). Preparations appear to have been underway by the end of 1816, for an entry in a mill ledger in December 1816 records that '*Thomas Allcock of Denton will undertake to make 200000 Good Bricks at 11/6 per Thousand*' (MA C5/3/1). Monies spent on the new mill, tunnel and waterwheel continue to appear in the partnership accounts until the period from September 1820 to March 1821, but these later payments may relate to the settling of accounts for work already completed. In November 1831 it was stated that '*The newest part of the Machinery, viz Water Wheel, Spinning and one Card Room [are] 12 years old*' (MA C5/8/16/1). Similarly, when the waterwheel underwent major repairs in 1847, it was said to have been in use for 28 years (MA C5/6/5). The wheel was possibly installed by 18 January 1819, when it was recorded that '*The bottom of the Tunnel 10 yards from the Wheelrace is 9' 1" below the bottom of the wheelrace or 9' 5" below the wheel. The tunnel at said point is 2' 8" below the high point at the Garden Pit*' (MA C5/8/9). A mill ledger records that on 26 January £400 was paid to Thomas Hewes at Manchester, possibly as acknowledgement for its delivery and installation, although a succession of smaller payments made to his representatives between March 1819 and January 1820 imply further ongoing work on the new power system (MA C5/1/4/1).

3.5.4 Other evidence shows that works were sufficiently complete for the New Mill to come into operation by late September 1819. A mill ledger states that on 25 September 1819 '*Spinning Frames [were] completed and set to work*' in the '1st Spinning Room' in the New Mill (MA C5/3/1). According to the Mill Memoranda, beginning in April 1819, new throstles (*Appendix 1*) were being delivered to the mill, made by Francis Sleddon of Preston (QBM Mill Memoranda, 38-9). The mill ledger similarly records several days between April and June 1819 when new throstles '*from Preston [were] set to work*' and adds that this was in the '*1st Room Old Mill – Afterwards removed into the 3rd Room New Mill*' (MA C5/3/1). It appears that new equipment was being ordered in advance of the opening of the New Mill, and was transferred there once the building had come into operation.

3.5.5 New machinery continued to be provided into the early 1820s. The Mill Memoranda notes the purchase of new carding engines (*Appendix 1*) and other preparatory equipment between 1819 and 1822 (QBM Memoranda, 39-40). According to the partnership book, by March 1823 the spindleage at the mill stood at 9600, double the figure for the Old Mill in 1818 (MA C5/1/2/3).

3.5.6 The addition of the New Mill and the acquisition of new machinery brought about an internal reorganisation of the mill processes. As early as 1819-20 the four floors in the New Mill above the waterwheel were named the 1st, 2nd , 3rd and 4th Spinning Rooms, with the 1st, which was also known as the Bottom Spinning Room, being the lowest and the 4th the highest. At the same time, in the Old Mill the four floors above the basement became the 1st, or Bottom, the 2nd, 3rd and 4th Card Rooms (MA C5/3/1; Figs 17, 18, 26). The effect of this reorganisation is evident from the valuations of the mill in the early 1830s. The valuation of 1831 lists carding engines (*Appendix 1*) in the four Card Rooms, with others in the '*Bottom place near Scutching room*' (MA C5/1/1/3).

3.5.7 The valuation of 1834 lists carding engines, along with other preparatory equipment, in the Bottom, 2nd and 3rd Card Rooms. In the same valuation, the 1st, 2nd, 3rd and 4th Spinning Rooms each contained 24 throstles, with ten more in the 5th Spinning Room, presumably the New Mill's attic (MA C5/1/1/4). The arrangement of the mill was disliked by Robert Hyde Greg, who complained to his father in May 1829 that there would be need for fewer overlookers '*if the mill had been properly made with two cardrooms instead of four*' (MA C5/8/2, cited by Rose 1986, 51). In the 1830s he converted two of the carding rooms to mule spinning (*Appendix 1*).

3.5.8 The 1822 insurance plan includes the stair tower of the New Mill, described as containing a stone staircase (Fig 12, D), and two other compartments projecting from the east elevation, which were first identified on an 1855 mill plan as a privy tower and a hoist (Fig 45).

3.5.9 With the construction of the waterwheel in the New Mill, the two wheels in the Old Mill became surplus to requirement. They seem to have been removed by 1822, when the insurance plan mentions only the New Mill wheel and describes the basement of the Old Mill as comprising '*a mechanic shop and cleaning cotton room*' (Fig 12, A).

3.5.10 From a plan of 1834 it is known that the mechanics shop occupied the southern half of the cellar; the scutching (*Appendix 1*), or cotton cleaning, room occupied the northern half and contained four blowing machines, which are also listed in the valuations of 1831 and 1834 (Figs 14 and 174; MA C5/1/1/3; C5/1/1/4). (There is also an undated 'Plan of the Scutching Cellar' in the Quarry Bank Mill archive which shows a different arrangement of machinery (Fig 15). Scutching machines were among the preparatory machinery bought between 1819 and 1822. Excavation in 1995-6 recorded possible drains set into the backfill of the 1784 wheelpit. Given the documented use of this area of the mill in the 1820s and 1830s, these may in fact have been flues for the blowing machines in use here at that time. In about 1833, in response to the Parliamentary commission on factories, it was stated that at Quarry Bank Mill '*In scutching (cleaning the cotton), the dust and flock is carried off through flues by means of powerful fans, leaving the room perfectly free from inconvenience*' (PP 1834 XX, D1, p 301, no 238).

3.5.11 A continuous range of three buildings lay between the Old Mill and New Mill and the river by 1822. The most northerly of these was the single-storey building used as a scutching room, which, as noted above, may have been built in 1810, in the middle was the Waste Room and to the south was the Mixing Room and they were in place by 1822. Just to the south end of the 1810 engine and boiler house, a doorway in the west wall of the Old Mill linked this room with the scutching room in the mill basement (Figs 14 and 174).

3.5.12 Between 1822 and the early 1830s, the steam engine seems to have not been used. In the response to the Parliamentary commission's question on the form of motive power at the mill, the firm answered '*Water, ninety horse-power; stream irregular, occasionally a day or a day and a half lost by floods. In dry seasons, for some weeks, only three-quarters of daily work done. In ordinary seasons, a few hours lost daily for two or three weeks*' (PP 1834 XX, D1, p 301, no 238).

3.5.13 The 1831 valuation of the mill also makes no mention of a steam engine, only 'Steam pipes and Boiler' (Table 4), and a plan of June 1834 likewise shows the position of the boiler within the engine and boiler house, but not of the engine itself (Fig 14). It would appear that by the early 1830s the engine had been removed, presumably being of insufficient size to power the mill by this date, leaving the boiler to serve the mill's heating system.

3.5.14 The 1810 engine and boiler houses are not shown on a plan of July 1834, and their site then formed part of the single-storey scutching room (Figs 13 and 174). The same arrangement appears on a mill plan of December 1836 and two other mill plans of about the same period (Figs 16, 23-25). In August 1834 Robert Hyde Greg was evidently considering acquiring a new boiler for the mill, since at that time Boulton and Watt provided quotes for a 20hp boat boiler and a 30hp land boiler (QBM Memoranda, 51). Greg's enquiry seems to have been in anticipation of the ordering of a new engine, which was eventually bought and installed in 1836 in an engine house built against the north wall of the Old Mill (*Section 3.7.5*). However, no new boiler is known to have been installed until 1843 and, according to the Mill Memoranda, the old boiler of 1810 continued in operation until that time, possibly having been '*repaired and strengthened*' (QBM Memoranda, 50), and probably altered substantially to provide sufficient steam pressure to the new engine.

3.5.15 The boiler installed in 1843 was situated in a boiler house adjoining the north-west end of the engine house. However, the mill plans of *c* 1836 show a narrower and shorter structure in that same location, running along the north side of the single-storey scutching room (Figs 23-25). The same structure also appears on the depiction of the mill on the Greg estate survey compiled in 1836, although here it is shown as unroofed (Figs 3 and 174). It is possible that this was itself built as a boiler house, and that the original boiler of 1810 was moved here in 1834.

3.5.16 In 1822 adjoining the south of the single-storey scutching room was a single-storey range identified on the insurance plan as a '*room for Picking and Sorting Cotton one story*' (Fig 12, H), and on 1834 drawings as a single-storey '*waste room*' (Fig 174 – Building 3). This was set back the same distance from the river's edge as the scutching room, such that both buildings were adjoined to the west by a strip of land that was used in 1834 as a garden (Figs 14 and 16). To the east was a narrow yard which separated the Waste Room from the Old Mill. On the south side, the waste room was abutted by a building that was identified on the 1822 plan as '*a room for raw cotton, two stories and packing room*' (Fig 12, K; Fig 174). On an 1834 plan and cross-section this building was shown as comprising a half basement (marked as a cellar) with two floors above; the lower being a mixing room, the upper being a making-up room (Fig 16) (this building was depicted on the plan as a mixing room). The north end of the building formed a separate room (described as a Scutching Room), which seems to have been extended to the south between 1822 and 1834. A plan of that later year describes it as a '*mechanics store room*' (Figs 14 and 174). The position of this last building (Mixing / Making Up Room) in relation to the New Mill suggests that it may be no earlier than the New Mill, and therefore to date between *c* 1818-19 and 1822 (Fig 174). The waste room (the central room), which appears to post-date the 1810 valuation, may have been built as part of the same phase of expansion and reorganisation.

3.5.17 The range referred to as the Greg Rooms, replacing the earlier workshops building, to the south of the New Mill, was originally of two storeys but was raised in 1885 to three; it was first shown on mapping of 1834 (Fig 16). The evidence for the function of the two-storey range is consistent from the 1840s onwards. A mill plan of 1844 identifies the building as containing a '*Counting House, Smithy and Mech[ani]c Shop*' (Fig 42). A plan of 1855 shows the southern part of the building, measuring 21ft by 24ft, to have contained a blacksmith's on the ground floor and a counting house on the floor above, while the remainder of the building, measuring 33ft by 24ft, contained a mechanics' shop on the ground floor, and a joiners' shop above this (Fig 45). Later valuations of the mill, in 1890, 1910 and 1923, show the same arrangement, although in these the counting house area is described as comprising a general office and a back office (Table 9). The plan also omits the stables (Fig 174 Building 7) and early warehouse (Fig 174 Building 5), both of which were probably standing at that date but were not included within that particular insurance policy. The 1810 valuation lists 'workshops', with an area of 59 sq yds (Table 2) (Fig 174 - Building 17). This closely corresponds with the footprint of the smithy and counting house that were part of the two-storey range, raising the possibly that the western part of that building was in existence in 1810 with the remainder being added by 1822.

3.5.18 A lodge, situated between the east wall of the mechanics' shop and joiners shop and the west wall of the stair tower of the New Mill, possibly first appears on mapping of 1834 (Fig 3) but was certainly in place by 1836 (Fig 23); it was identified by name on the mill plan of 1844 (Fig 45).

3.5.19 The mill manager's house, now Mill Cottage, at the southern end of the mill buildings, is sometimes dated to 1810. This can be traced back to Lazenby (1949, 111) who states that the house '*was built for Thomas Barton, the Manager in 1810*', but unfortunately cites no source. The Mill Memoranda places the construction of the manager' house with the general expenditure associated with the building of the New Mill (QBM Memoranda, 4). Account books show that in reality it was built a few years after the New Mill, in 1824-5 (MA C5/1/2/4, C5/1/4/2; Rose 1977, 123). In 1847, when the apprentice system ended at the mill, the Apprentice House was divided into two dwellings, one of which became the residence of the mill manager James Henshall, while the former manager's house was then occupied by the mill's book-keeper, John Waterworth (Rose 1977, 124).

3.6 1836-70 – POWERLOOMS AND ASSOCIATED DEVELOPMENT

3.6.1 The decision by Robert Hyde Greg to install powerlooms at Quarry Bank prompted the next major phase of development. The Mill Memoranda reports that the first of these looms were set up in 1836-7 in what were previously the mixing and making-up rooms in the building which then stood to the west of the New Mill (QBM Memoranda, 55). However, shortly afterwards two new purpose-built, multi-storey weaving blocks were erected to house the mill's looms. One was built to the south of the former mixing and making-up rooms, and replaced the early cotton warehouse. As originally built this comprised two storeys above the cellar, but a third storey was added in 1842 (*ibid*).

3.6.2 The other new weaving block, which was of two storeys, adjoined this on the north and replaced the former waste room. A undated drawing, which shows a ground plan of the mill and the eastern elevation of the weaving blocks, implies that this building incorporated the former mixing and making-up rooms, four bays long, to which a two-bay extension was added on the south and a six-bay extension on the north (Fig 25).

3.6.3 This undated drawing also shows that the northern weaving shed was abutted on the north by a narrow single-storey building eight bays long, which occupied the former garden area between the river and the single-storey scutching room. No documentary evidence has been found for the addition of this narrow range, but that it was actually built seems to be confirmed by Cawley's survey of Wilmslow parish in 1841 (Fig 4). An undated drawing of a half-truss for a monopitch roof, for a building possibly erected against an existing structure, may relate to this narrow range (Fig 32).

3.6.4 Preparations for the new weaving buildings were evidently underway by December 1836, when a plan of the mill includes cross-sections of the current ground levels on their site (Fig 23). A drawing of a roof truss for the southern weaving shed is dated 18 August 1837 (Fig 28), and there are other plans of this roof and of the roof structure of the northern weaving block which are undated (Figs 29-32). A mill ledger shows that building work was being carried out between September 1837 and March 1838 (MA C5/1/4/3), and, according to the Mill Memoranda, the sheds '*were completed so far as to receive looms about the end of the year 1838 or beginning of 1839*' (QBM Memoranda, 55).

3.6.5 Perhaps in anticipation of the installation of powerlooms, Robert Hyde Greg also improved the mill's steam-power system. In October 1835 Boulton and Watt provided estimates for both a 20hp boat engine and a 20hp independent engine. An order was placed for the second of these, and the engine was installed the following year in an engine house built against the north wall of the Old Mill (QBM Memoranda, 52-4; MA C5/1/4/3) (Figs 20-22).

3.6.6 A plan in the Boulton and Watt Archive dated 31 December 1835, known from a copy held at Quarry Bank Mill (QBM 9), shows both the proposed new engine house and a new boiler house. This abutted the west end of the engine house, and on the south extended the full width of the 'blowing room' to the river's edge – an indication that there were plans to either extend or rebuild the old scutching room as early as this date. The boiler house on this plan carries an annotation by the millwrights Wren and Bennett, which describes this as the '*Proposed situation for a 30h Boiler not yet ordered*'. In August 1834 Boulton and Watt had provided costs for a 25hp boat boiler or a 30hp land boiler for the mill, and the figures given in October 1835 also included the option of a new boiler. This was not ordered and the old boiler, installed in 1810, is believed to have remained in use until 1843 (QBM Memoranda, 50-4). As noted above (*Section 3.3.4*), from 1834 this was possibly located in a new boiler house situated in the same position as that built in 1843 but this was somewhat narrower and shorter.

3.6.7 The expansion into powerloom weaving meant that, whereas the mill had previously specialised in the production of coarse yarn for warps, weft was also now required. For this purpose in 1838 mules were installed in the mill, supplied by Sharp Roberts and Co of Manchester (QBM Memoranda, 57-8). This involved an internal reorganisation of the existing spinning mill buildings. An undated plan shows the 2nd Room of the Old Mill filled with three pair of self-acting mules arranged along the length of the room (Fig 27), and the 1844 plan of the mill indicates the both the 2nd and 3rd Rooms of the Old Mill contained mules. The 1st and 4th Rooms continued to be used for carding, and New Mill for throstle spinning (Fig 42).

3.6.8 In 1842 there was a proposal to construct a gas works at the mill. A plan for a retort house and gasholder was drawn by William Kay of the Phoenix Foundry, Bury, but for reasons unknown the scheme was not taken any further at this time (Fig 33; QBM Memoranda, 59-60; West 2006).

3.6.9 Investment in new buildings, however, continued in the mid-1840s. In 1843 the scutching room to the west of the Old Mill was replaced by a two-storey building, in which the ground floor was used as a blowing room, and the upper floor as a mixing room (QBM Memoranda, 60-1). The plans drawn up in May 1843 in connection with its construction and equipment are the fullest to have survived for any of the mill buildings, and included details of the underfloor flues which served the blowing machines (Figs 34-39). The building was of a fireproof construction, with brick jack-arches supported by an iron frame, and was separated from the Old Mill by a narrow passage, made narrower by the new building's semicircular stair tower, as well as by the existing privy turret and chimney projecting from the west wall of the Old Mill (Building 4f on Fig 173). A ground plan shows the new building's eight-bay western wall, and the returns of its north and south wall, appears to have been reused from an earlier structure (Fig 34); this must have been the narrow single-storey range built along the west side of the old scutching room a few years before. Power was transmitted to the new scutching room via two runs of line shafting from the Old Mill. According to the Mill Memoranda, when the new scutching room opened, the former blowing room in the cellar of the Old Mill became a cotton store (QBM Memoranda, 61), a use documented on the 1844 mill plan and by later sources until the early twentieth century (Table 7).

3.6.10 In 1843, a new 31hp boiler was acquired from Boulton and Watt (QBM Memoranda, 54) (Figs 40-1). This was installed in a new boiler house which abutted along the west end of the engine house, and extended along the north wall of the scutching room as far as the river. A plan of the new scutching building shows that at the same time it was proposed to rebuild at least the lower part of the old boiler house chimney, possibly to accommodate a new flue (Fig 34). As noted above, the boiler house built in 1843 possibly replaced a smaller boiler house into which the 1810 boiler may have been moved in the 1830s.

3.6.11 A cloth warehouse was erected on the north side of the mill stables in the mid-1840s (Fig 45). Its construction is dated to 1845 by a mill ledger, and to 1846 by the Mill Memoranda, which also notes that '*The cloth had hitherto been sent off as made up from day to day, there being no convenience for stocking*' (MA C5/6/5; QBM Memoranda, 62). Specifications for the roof, dated to 1846, survive and include a sketch of one of the four roof trusses (Fig 43). The timber was '*to be of good Quebec Pine and firmly put together, with 2 Skylights fixed in the roof, each light 6ft x 4ft*' (QBM T11382). This warehouse was directly linked to the weaving rooms by a bridge or gangway, shown on the 1855 mill plan (Fig 45).

3.6.12 The 1855 mill plan also provides the earliest known evidence for a second gangway, linking the weaving rooms with the hoist in the south elevation of the New Mill. This gangway was replaced in 1879, having become decayed and unsafe (QBM Memoranda, 114). The hoist itself was replaced in 1845, with new gearing by Wren and Bennett and a new frame and ironwork by the mill's mechanics and joiners (QBM Memoranda, 61; Valuation 1910).

3.6.13 With the construction of the warehouse in 1846, the ground plan of the mill buildings used in the production and processing of yarn and cloth effectively reached its maximum extent. In 1850 there was a proposal to enlarge the Old Mill by removing 90ft of wall and widening that portion by 13ft, presumably referring to the east side of the mill between the stair tower and the New Mill, and at the same time to re-roof the Old Mill, making the attic storey the same height as that of the New Mill (QBM Memoranda, 68). For reasons unknown this proposal was not put into effect. Additions to the mill that were carried out after 1846 principally relate either to modifications to ancillary buildings, or the construction of new buildings for steam power and gas production.

3.6.14 The waterwheel was repaired by Wren and Bennett in 1844 after 13 buckets were stripped off (QBM Memoranda, 62-3). More extensive repairs, totalling approximately £2000, were undertaken in 1847, which included the replacement of the axle (QBM Memoranda, 63-67; MA C5/6/5). In 1849 the mill manager James Henshall estimated that the annual cost of generating 100hp at the mill through steam power would be £416, compared with £107 7s using water power (MA C5/6/5). In 1856 it was reported that '*Out of the 312 working days in the year, there are probably about 100 on which we can work more or less without the engine*' (QBM Memoranda, 69-71; MA C5/3/2). In December 1850 new gearing was added to the upright shaft in the Old Mill, allowing this to be disconnected from the waterwheel and driven by the engine (MA C5/3/1). According to the Mill Memoranda, the waterwheel drove all the mill until the 1870s with the exception of the blowing room and, during water shortages, the Old Mill (QBM Memoranda, 83).

3.6.15 In 1853 the Boulton and Watt steam engine installed 17 years earlier was McNaught'ed by the Manchester engineers Peel and Williams (QBM Memoranda, 69) (a modification developed by William McNaught to improve the efficiency of an engine). In the same year, and presumably to provide the necessary power to the engine, a second-hand boiler was bought from David Bowlas and Co and was installed in a new boiler house built at the east end of the engine house (*op cit*, 68; Figs 44-5; Building 5d on Fig 173).

3.6.16 The boiler at the west end of the engine house, installed in 1843, remained in place and was '*used occasionally for heating purposes*' when the old boiler was being cleaned or repaired. It was eventually removed in 1871, when the boiler house was reused for a new engine (QBM Memoranda, 54).

3.6.17 In 1864-5 a retort house and gasholder were finally installed at the mill by Kays of Bury (QBM Memoranda, 75-6), for which plans were drawn in December 1863 (Figs 46-7). These show the retort house divided into two chambers, with the eastern chamber containing five retorts in three benches, and eastern chamber housing a purifier and tar well. The plans also indicate a vertical tube condenser on the outside of the north wall, where black scorch marks from the condenser are still evident (West 2006).

3.6.18 A ledger records that in March 1855 a shed was erected 'over the Tea Boiler in Mill Yard' (MA C5/3/2) (Fig 174). Later sources describe this arrangement, which provided the workforce with hot water at meal times, as comprising a copper boiler, or set pan, on a brick base with a corrugated iron roof, positioned next to the smithy so that the flue was connected to the mill chimney. In 1905 this was replaced by a steam kettle set up near the privies at the south end of the weaving sheds (QBM 1890 Valuation, Table 9; QBM Memoranda, typescript copy, 203).

3.7 1870-1900 – INVESTMENT UNDER EDWARD HYDE GREG

3.7.1 In 1870, on the retirement of his father, the mill came under the sole control of Edward Hyde Greg. He invested heavily in new machinery in the following few years, with the highest peaks in expenditure during this period occurring in the early and mid-1870s (Rose 1977, Appendix 2, Table D). This reflects to some degree the prosperity of the cotton industry during the early 1870s, which resulted from a surge in the national economy coupled with a sharp rise in the European demand for British cottons (Miller and Wild 2007, 85). Notwithstanding the 'Great Depression' of 1873-96, the average spinning firm expanded from operating 16,872 spindles to 36,504 between 1870 and 1890 (Marrison 1996, 241). This period also saw the gradual adoption of ring spinning across the region, which were capable of exceeding the yarn output of spinning mules (Williams with Farnie 1992, 122-3).

3.7.2 In 1871, Willan and Mills of Blackburn supplied 101 new looms to Quarry Bank Mill, which were added to other looms purchased in the 1860s (QBM Memoranda 72, 76-7, 81). In 1874 the throstles in the 3rd Room in the New Mill were replaced by machines made by Evan Leigh Son and Co Ltd, Manchester, who, in 1876, also supplied new throstles for the 2nd Room (QBM Memoranda, 100). In 1876 the mill also acquired five new mules made by the Globe Iron Works Co Ltd, Manchester. Four of these were set up as two pairs on each in the 2nd and 3rd Rooms of the Old Mill, where they replaced the mill's original mules. A fifth mule was set up in the 4th Room, where it formed a pair with a mule which had been obtained from the Globe Iron Works in 1871. This single mule had been first installed in the Bottom Spinning Room of the New Mill. On its removal in 1876, this room was converted to a card room (QBM Memoranda, 82, 107; QBM Valuation 1890).

3.7.3 When ring spinning was introduced into the mill in the 1880s, the original intention was to convert the existing throstles. However, these were found to be unsuitable for conversion, and, between 1886 and 1890, three ring-spinning frames were bought from Samuel Brooks of the Union Iron Works, Gorton, and were set up in the 2nd and 3rd Rooms of the New Mill, alongside throstles. In 1891 two weft ring frames, acquired from the same firm, were set to work in place a pair of short mules in the 2nd Room of the Old Mill (QBM Memoranda, 136-7, 149, 154-5, 163, 173-83; Valuation 1890).

3.7.4 However, it would seem that this experimentation with new spinning machinery was not entirely successful, as a decision had been reached by 1894 to concentrate production on the weaving department, and the firm's spinning machinery was sold by auction in December of that year (QBM Memoranda, 173-83). The following year the fireproof building, formerly used as the scutching room and mixing rooms, was fitted with new looms manufactured by the Bankhouse Ironworks, Burnley (QBM Memoranda, 185).

3.7.5 In June 1872 a severe flood destroyed a causeway which had previously divided the river above the weir into a narrow channel for the water to flow through and a separate reservoir for storing the water. This division had helped to restrict the silting process, which now began to reduce the water supply to the mill. Attempts were made to remedy the situation in 1881 and 1908 but were unsuccessful (Matrix Archaeology 2010).

3.7.6 One year prior to the flood, in 1871, a new 60hp horizontal engine was bought from Martin and Smethurst of Guide Bridge, primarily to provide power to the weaving rooms in order to lessen the load on the waterwheel. This new engine was set up in the boiler house built in 1843 (Fig 48), where the old boiler was removed and new foundations were put in place for the engine. Power was transmitted from this engine to the weaving sheds via the scutching room (QBM Memoranda, 84-90). The 1836 engine was retained as a stand-by. In 1884 it drove the Old Mill while the gearing of the upright shaft was being repaired, and in 1887-8 it was in use while repairs were carried out to the 1871 engine (*op cit*, 130, 140-1, 145-6, 161). In 1891 further pressure was taken off the waterwheel by carrying a drive shaft from the scutching room to the cotton store in the basement of the Old Mill; from here, via a new upright shaft, power was provided to the bottom card room (*op cit*, 159). The New Mill and the upper floors of the Old Mill continued to be driven by the waterwheel. This meant that in the winter of 1891-2 and again in 1893, while the waterwheel was under repair, the throstles in the New Mill were temporarily out of action, and the mules in the Old Mill were driven by the old engine (*op cit*, 161, 169).

3.7.7 The 1853 boiler had a safe working pressure of 40lb, inadequate for the new engine, and in 1871 a new boiler was bought from Hick Hargreaves and Co of Bolton. The specifications describe this as 28ft long, 7ft wide, with two flues 2ft 9in in diameter. It was installed in a new detached boiler house which was built into the bedrock to the south-east of the 1853 boiler house (QBM Memoranda, 90-3; Milln 1995, 21-2, 25 Fig 7 O and P; Fig 7). The 1853 boiler remained in place until 1880.

3.7.8 The installation of the new boiler in 1871 led to the building of a new chimney. The Mill Memoranda noted that '*It had long been found that the old chimney was too small for the economical consumption of fuel, and altogether inadequate when two boilers had to be used together*' (QBM Memoranda, 104). The new larger chimney was built in 1875 at the north-east corner of the mill. The contract for its construction was awarded to Edward Barlow of Stockport (QBM Memoranda, 104-6), who also reduced the height of the old chimney to roof level in January 1883 as it had become unsafe (QBM Memoranda 124).

3.7.9 Other instances of structural remodelling are known to have been implemented during the mid-1870s. In 1875, for instance, the arch over the waterwheel was relieved by the insertion of two pairs of iron beams (QBM Memoranda, 103). Only one of these pairs of cambered I-beams remained in place by 1963, the other possibly having been removed when the turbine was installed in the wheelpit in 1904 (*op cit*, 236-7; Lindsay 1963, 26).

3.7.10 In 1876 (*Section 3.7.1*) the 1st Room of the New Mill was converted to a card room. Access into this room had formerly been via the stair tower but, to allow space for carding engines, a new doorway was built, opening onto an external landing (QBM Memoranda, 108).

3.7.11 In 1876-7 a two-storey extension was added at the south end of the workshops and office building. The upper floor contained a private office, communicating with the general one, while the lower floor was used as an oil store and general store (Building 5c on Fig 173). '*This latter room was fitted up with 2 zinc oil cisterns placed on a stillage against the wall up to the road, it being intended to pump the oil into them out of the casks as they stand on the lorry or cart, by means of a spout through the wall'*. The site of the extension had been occupied previously by men's privies, which were replaced by new privies built in about 1875 at the south end of the weaving sheds (*op cit*, 101-2).

3.7.12 In 1877 a new stable building was built to the south of the former manager's house. Prior to that time carriage of materials and coal for the mill had been undertaken by tenant farmers but the additional stabling allowed this to carried out directly by the firm (QBM Memoranda, 109-10). From this date, as before, the original stables building, erected in 1803, seem to have been used solely for Quarry Bank House (QBM Memoranda, 194) (Fig 174 (Building 7).

3.7.13 From the 1880s building operations were more sporadic. In 1880 the boiler in the 1853 boiler house was replaced. The new boiler was built by Thomas Oldham of the Wellington Works, Stockport, and was of the same size as that installed in the 1871 boiler house, being 28ft by 7ft (MA C5/1/4/4; QBM Memoranda, 116-8; Milln 1995, 21-22).

3.7.14 In same year, 1880, quotations were provided for replacing the old low-pressure steam heating system in the mill, except for the weaving rooms, with wrought-iron high pressure pipes. It is unclear as to how much of this piping was installed, since heavy inefficient cast-iron pipes are also stated to have been used to heat the mill, with the exception of the old blowing and mixing rooms, until 1905, when small-bore wrought-iron piping was fitted (*op cit*, 119, 246).

3.7.15 To help reduce the cost of fuel, an economiser (*Appendix 1*) was bought from Greens of Wakefield in 1889. To accommodate this, the 1880 boiler was moved 20ft eastward, requiring further excavation into the bedrock (QBM Memoranda, 152-3: Milln 1995, 23-24). The Hick Hargreaves boiler was retained and in January 1902 was used when the Oldham's boiler was cleaned and repaired (QBM Memoranda, 199-200).

3.7.16 In 1885 an upper floor was added to the main workshops and office building, to be used for the sizing of warps. Until that time this process had been carried out by the limited company of Samuel Greg and Co at Bollington, which collected and returned the warps twice a week by wagon. The Mill Memoranda records that the introduction of sizing to Quarry Bank Mill had been under consideration since 1878 but the problem had been in finding a place for sizing machinery and size mixing apparatus. '*It was finally decided to build a new storey over the present joiners shop and office using the cellar underneath the private offices, used as an oil general store for the vats containing size to be pumped up to the sizing room above when required*'. The sizing machinery was supplied by Howard and Bullough of Accrington, while the size mixing apparatus, together with the piping and pumps, was supplied and installed by Thomas Parkinson of Blackburn. The addition of the new storey required '*strengthening of the lower storey - as it was discovered that the foundations were not very good, and in close proximity to the Tunnel*', ie the headrace (QBM Memoranda, 132-4). Size mixing (*Appendix 1*) is later recorded as taking place next to the sizing room, in a third storey built above the lodge (QBM Valuation 1910). The Mill Memoranda does not separately state when this room was added, and it is presumed to have formed part of the 1885 works.

3.7.17 In 1888 '*the partition wall between what was formerly the cop cellar and the bottom weaving room was taken down and a strong beam thrown across*', thereby allowing looms to be placed further apart (QBM Memoranda, 144-5).

3.7.18 In the 1890s the end of spinning and expansion of weaving brought other changes. In late 1894 in advance of the change, remedial work was carried out on the three-storey weaving shed (Building 4d; Fig 173) . The wall facing the mill yard, which was leaning out of true, was underpinned, pillars were inserted in the ground-floor weaving room to carry the weight of the machinery above and relieve the load on the walls, and the floor was also strengthened by fixing bearing timbers underneath (QBM Memoranda, 184-5).

3.7.19 In 1885 the passageway between the blowing room and the Old Mill was covered over, so that the blowing room was now accessed directly from the cotton store room in the Old Mill basement (QBM Memoranda, 137). In 1895 when the former scutching and mixing building was converted to weaving, its upper floor was linked to the Old Mill by putting a floor across the passageway between the two buildings and '*making a doorway out of the bottom card room opposite the door through which the bales of cotton were formerly taken; and also to the yard by a flight of wooden steps*' (*op cit*, 185). In the spring of the same year, a glass roof was erected over the mill yard between the weaving buildings and the Old and New Mills to provide an area for unpacking the cops of yarn which were now brought to the mill.

3.7.20 The result of this work is evident on Ordnance Survey mapping of 1896-7 (Figs 8 and 174). To assist with the unloading of cops of yarn and loading of empties, in 1895 a friction hoist was bought from John Barker and Sons, Oldham. The working part was fixed in the joiners shop and the rope passed through the wall and over a jib arm. This arm was lengthened and strengthened in 1904 (*op cit* 188, 213), although there is little surviving physical evidence for these alterations.

3.7.21 The expansion of weaving meant that the existing storage area for size, in the room below the private office, was no longer adequate. However, an area within the waterwheel house of the New Mill, which had previously been used as a weft cellar, was no longer needed for that purpose. In the summer of 1895, size steeping was moved to this area, where a new pine vat measuring 16ft 3in by 5ft by 5in was installed (QBM Memoranda, 187). This process continued here until at least 1922 (*op cit*, 83).

3.7.22 ***Communications:*** the road access and communications for Quarry Bank Mill had been fairly static, but is best represented on the available Ordnance Survey mapping in the second half of the nineteenth century. The access for vehicles and also pedestrian traffic was along Quarry Bank Road, which extended out from Styal Green and followed a raised route along the eastern side of the Bollin valley and led to the north-eastern corner of the mill where it turned sharply right to follow the present bridge over the River Bollin. A diverted carriageway led off the main road to provide more private access for Quarry Bank House. The sharp turn was immediately adjacent to the coal shute for the New Boiler and would have provided easy access for coal deliveries. An off shoot track leads off from the road and extends past the east side of the mill and from as early as the 1836 map (Fig 3) it led into the courtyard in front of the stables. A further track led directly between the west side of Quarry Bank House and the courtyard, and this corresponds to the present day footpath. This arrangement has not significantly changed between the 1936 map and the 1968 OS map (Fig 11).

3.8 1900-59 – TWENTIETH-CENTURY EXPANSION AND DECLINE

3.8.1 The 1900s brought both an expansion in the weaving capacity of Quarry Bank Mill, presumably combined with the cessation of spinning, and with the introduction to the mill of the Northrop loom. The decade also saw the replacement of the waterwheel with a turbine system, and heavy gearing replaced by rope drives.

3.8.2 In 1904, 72 second-hand looms from Cressbrook Mill were installed in the 2nd Room of the Old Mill (QBM Memoranda, 225). Three other looms were added to this room in June 1905, bringing the total number in the mill to 487 (QBM Memoranda, typescript copy, 202). In 1905-6 the former mechanic's shop in the cellar of the Old Mill was also converted to a weaving room, containing 30 looms (*op cit*, 213, 221-4). The mill's first Northrop looms were installed in 1909, when 84 were acquired from Greg Bros and Co. Sixty of these were accommodated within the ground floor of the large weaving building (Fig 50), displacing the existing looms here which were moved to the first floor.

3.8.3 The other 24 looms were installed in the former mechanic's shop in the Old Mill, and the looms from there were moved to the narrow weaving building (QBM Memoranda, typescript copy, 264-7). An additional 44 second-hand Northrop looms were bought in 1913, and were set up in the upper room of the fireproof building (QBM Memoranda 1910-25, typescript copy, 33). Northrop winding frames were also located initially in the narrow weaving building but, in 1911, were transferred to the 2nd Room of the New Mill, which at the time was used as a store room for yarn (*op cit*, 8, 10; Fig 55).

3.8.4 The replacement of the waterwheel with a turbine was under consideration in 1899, when plans were provided by Gilbert Gilkes and Co of Kendal. In 1904 the deteriorating condition of the waterwheel and an improvement of trade led to the proposal being revived. It was decided to install two turbines, the larger one of 200hp to be the main power source, and the smaller of 20hp to be used to drive the machinery in the building containing the mechanic's shop and sizing room (Fig 49). On 20 September 1904, while these plans were underway and the waterwheel was still in operation, the pinion of the wheel stripped, '*the shock being felt through all that portion of the mill driven by the upper pinion...On examination it was found that a large piece had broken out of one of the segments and fallen to the bottom of wheel race, also a piece was broken out of the shrouding. So ended the life of the water wheel which had worked continuously since 1847*'.

3.8.5 The waterwheel and its heavy gearing were removed in October, followed by the pentrough which was replaced by a wall of blue bricks, set flush with the face of the wheelpit, into which the pipes for the turbines were set. Support for the turbines was provided by two steel girders with one end set into the east wall of the wheelpit and the other carried by a girder spanning the width of the pit, although the original intention had been to reuse the waterwheel axle for that purpose. The Mill Memoranda records that '*There being no doorway or opening large enough to admit the shell of the large turbine passing through, a portion of the wall between the bottom room door and the hoist was taken down, and a portion of the bottom room floor was taken up and the shell and tail pipes and taken down that way*'. To make room '*one of the large cast iron struts straddling the wheel*' was also removed, possibly one of the cast-iron beams added to strengthen the roof of the wheel house in 1875 (*Section 3.7.8*). The work of installing the turbines was finished by 12 January 1905 when the large turbine was brought into operation. In the interim, power was provided by the mill's engines (QBM Memoranda, 227-37).

3.8.6 Rope drives driven by the large turbine provided power to the shafting in the narrow weaving building, where two steel girders were inserted to carry the rope pulley, and to the 2nd Room of the Old Mill, which, as noted above, had been fitted with looms in 1904 (48; QBM Memoranda, 230-1). '*About two thirds way down the room'* was an external rope drive, beneath a glass cover, which ran down to a line shaft between the Old Mill and the old blowing room to provide power to the fireproof building. Through the use of couplings, the shafting within the 2nd Room and the fireproof building could also be detached from the turbine and powered by steam (*op cit*, 231).

3.8.7 In June 1905 a trial was made at running the turbine and engine jointly, but '*though it was successful and no mishap occurred the day or two it was that the trial was made it was felt to be too risky to continue*' (QBM Memoranda, typescript copy, 202). Power to the weaving room in the basement of the Old Mill, formerly the mechanic's shop, was provided directly by the turbine's first motion shaft (QBM Memoranda, typescript copy, 267) (Fig 50). Plans of January 1905 show proposals for the transmission of power by a rope drive from the small weaving shed to the larger shed on its south (Figs 51a and 51b). In September 1906 an internal rope drive was installed within the larger weaving building (*op cit*, 232). Power was provided from the smaller turbine to the building containing the mechanic's shop and sizing room via shafting. In 1918 this building was fitted with an internal rope drive (QBM Memoranda 1910-25, typescript copy, 57-8; Fig 52).

3.8.8 In late 1906, the beam engine of 1836 was sold for scrap. The following year the engine house was reused to accommodate a second-hand 60hp engine, built by Marshall Sons and Co of Gainsborough, for use when there was insufficient water for the turbines. The engine's original flywheel was replaced with a rope-drum flywheel (QBM Memoranda, typescript copy, 233-4, 245-6). Survey of the engine house in 1994 recorded evidence of this flywheel in the form a scour mark, centred on a blocked bearing housing which was set within a former window of the 1784 mill (Fig 70). A surviving pulley on the same wall, above the engine house, was probably driven by the rope race (Fletcher 1995, 5). When the new engine was installed in 1907, the horizontal engine of 1871 was retained and during the drought of 1911 was brought into use again, '*having stood idle since the changes at the introduction of Turbines*' (QBM Memoranda 1910-25, typescript copy, 10).

3.8.9 The main mill buildings all underwent a number of alterations in the early twentieth century, some related to changes of uses, others to general repair, greater efficiency or economy, or to safety. At the Old Mill, old floor surfaces were replaced in preparation for the installation of looms. In the case of the 2nd Room, in 1904 this involved replacing the old floorboards with 3in tongued and grooved pine planks, each the width of the room. This new floor was found to shake, and in the following year an attempt was made to steady the boards '*by placing a 9 x 4 pitch pine along the middle of each and supporting them by 4 steel joists evenly divided over the whole length*' (QBM Memoranda, 225, 252). In the case of the former mechanic's shop, in 1905 the flagged floor was replaced with concrete (QBM Memoranda, typescript copy, 213). In March 1910, after Northrop looms were installed in that same room, two window openings were made in the west wall '*where there had been a window and doorway before*' (QBM Memoranda 1910-25, typescript copy, 1).

3.8.10 In 1913 dry rot was discovered in the 'old bottom card room floor', *ie* the 1st Room of the Old Mill, hidden by the sheet iron which covered the underside of the floor as fireproofing. At least one beam was renewed, along with all the joists and boards for about two-thirds of the area of the room (QBM Memoranda 1910-25, typescript copy, 35). In the same year dry rot was also discovered in one of the bays of the Old Mill roof, caused by a faulty gutter. In addition to repairs to the roof and brick parapet, the adjacent brick projections '*formerly used as a hoist race and closet were partially taken down*', and one window opening was infilled to strengthen the wall (*op cit*, 36).

3.8.11 This remedial work evidently affected the west wall of the 1796 mill, where early photographs show that the privy tower and hoist originally rose the full height of the mill (Plates 2 and 3).

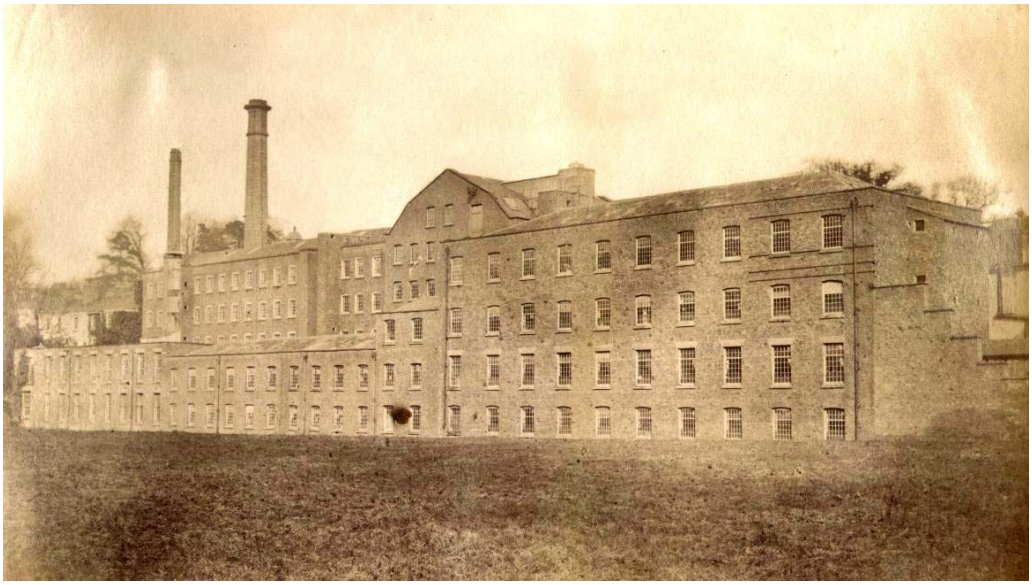


Plate 2: Rear of mill, photographed between 1875 and 1883, from album by John Tongue (QBM)

3.8.12 Further repairs were carried out in 1922 after dry rot was found to have attacked several beams in the attic of the Old Mill, including '*the one behind the chimney; the one by the partition forming Heald Room; the [one] by the flagpole*'; and also '*the beam end in New Mill near where the heavy vertical shaft used to be*' (*op cit*, 93). In 1925 a new window was inserted into the west wall of the Old Mill, '*borrowing light from the cabin under the clock tower...it having been found that there was a large flue in the wall cased on each side with a 4½" wall only*' (*op cit*, 111).

3.8.13 At the narrow weaving building, the four steps from the mill yard to the main door of the weaving shops were replaced in 1903 by a flagged slope, and the awning of the door was extended to cover this slope (QBM Memoranda, 207, 209). The ceiling over about half the upper floor of narrow weaving building was also removed in 1903 in order to reduce the insurance premium, since this was counted as another storey, and the roof was plastered and fitted with an additional skylight (QBM Memoranda, 209). The following year the upper floor of this building was strengthened '*by means of planks supported by steel joists run along the middle of each bay in the room below*'. As part of the same phase of work, the walls of a storeroom at the end of this weaving room were taken down and the roof brought into line with the rest of the building (QBM Memoranda, typescript copy, 206-7). This last work may reflect the fact that this building was constructed in the late 1830s and entailed adding extensions to the end walls of an existing structure (see above). In 1910, to provide sufficient heat to the upper room of the narrow weaving building, an extra steam pipe was added, running along its east side (QBM Memoranda 1910-25, typescript copy, 7).

Plate 3: Rear of mill and bridge over the Bollin, from album by John Tongue (QBM)

3.8.14 In the large weaving building, as part of the internal rearrangement in 1909, the old wooden floor of the first-floor room was replaced with new pitch pine planks (QBM Memoranda, typescript copy, 266-8). In 1913, when the old looms on the upper floor of the fireproof building (1843 Preparation Block) were replaced by Northrop looms, 29 of those old looms were moved to the cellar of the large weaving building. In order to get these in without being dismantled, '*the doorway at the end was enlarged and the earthwork outside cut away to form a slope*' (QBM Memoranda 1910-25, typescript copy, 33). A new fire exit was also inserted at the end of the ground-floor room of this building in 1925. This was made by lowering a window sill, leading out onto steps made from the grating of the old beam engine deck floor (QBM Memoranda 1910-25, typescript copy, 110). New swing doors, in two halves, were fixed in 1906 to the entrances to the cloth room (the upper floor of the large weaving buildings) from the overhead gangways (QBM Memoranda, typescript copy, 224).

3.8.15 In 1915 repairs were carried out to the top of the mill chimney, as part of which '*the large terra cotta blocks from the upper collar [were] removed*' (QBM Memoranda 1910-25, typescript copy 48). Later repairs in 1936 saw the removal of the chimney capping (Fletcher 2005, 93).

3.8.16 In 1907 the size mixing room, over the old mill lodge, was modified to improve ventilation. This room was previously ventilated '*by having a portion of the roof raised so that there was a free current of air through. In frosty weather however the water pipes were apt to be frozen up and to avoid this the front or road side portion of the entire roof was raised and the front for about 2 feet deep was fitted with louvre ventilation with shutters behind so as to close the apertures in case of severe frost. The back portion was left in the original position*' (QBM Memoranda, typescript copy, 249). Repairs were carried out to the roof structure of this room in 1925 (QBM Memoranda 1910-25, typescript copy, 42).

3.8.17 In 1919 a new doorway to the joiner's shop was created by converting the window '*next but one to the office*'. This was accessed from the roadway by a bridge made from a reused steel joist, cut into two, carrying a pathway made of concrete (QBM Memoranda 1910-25, typescript copy, 66). Previously, in 1914, one of the front windows of the joiners' shop had been replaced by a sliding door, to allow long timbers to be brought in (*op cit*, 41). The north wall of the warehouse was underpinned with brickwork in 1904, when the bedrock here was found to be crumbling (QBM Memoranda, 215).

3.8.18 The overhead gangways underwent successive repairs. In 1906 the eastern section of the gangway between the warehouse and the office was strengthened by bolting two steel joists to the main beams, and at the same time the wooden bearers were renewed (QBM Memoranda, typescript copy, 233). The western section underwent similar repair in 1923 (QBM Memoranda, 1910-25, typescript copy, 103). In the intervening period, in 1913 the floor of the gangway had been renewed and laid with iron plates '*so as to form an easy track for the cloth truck*' (*op cit*, 37).

3.8.19 The gangway between the hoist on the New Mill, the cloth room and the sizing room underwent work in 1907. The section in front of the hoist was widened and at the same time was repaired by fixing a steel joist on the underside and renewing the bearers and boards (QBM Memoranda, typescript copy, 250). In 1919 this steel joist was found to have been corroded by the spillage of sizing materials. Two new joists were then fitted to strengthen the gangway and were covered with lead as a protection against future corrosion. The old joist was removed and reused in the new entrance to the joiner's shop (QBM Memoranda 1910-25, typescript copy, 64). The hoist itself was repaired in 1904, when a new wooden cage was fitted by Higginbotham and Mannock Ltd of Manchester. The gearing manufactured by Wren and Bennett in 1845 was still in good working order and was retained. The doors leading into the hoist from each floor were widened, with a steel joist as a lintel, to allow a truck containing yarn to pass through (QBM Memoranda, 215; Valuation 1910). In Feb 1906 a locking arrangement by Higginbottom and Mannock Ltd was fitted to the hoist (QBM Memoranda, typescript copy, 223). The old hinged doors of the hoist were replaced by sliding ones in 1907 (*op cit*, 250).

3.8.20 Other changes affected the ancillary buildings at the south end of the mill. In 1904 the firm entered into an agreement for gas to be supplied from the mains of the Wilmslow and Alderley Gas Company. A meter was installed in a former oil store attached to the north end of the former manager's house (Table 9), from where the gas passed to the existing gasholder and then through the existing service pipes to the mill (QBM Memoranda, 214, 223-4). The ironwork of the disused retort house was sold for scrap in November 1904 (*op cit*, 237). In the following year, the brickwork inside the retort house was removed and a large doorway was cut into the side wall to enable the building to be used as a cart shed (QBM Memoranda, typescript copy, 203). In 1910 this building was described as also being used as a fives court (QBM Valuation 1910). The gasworks chimney was taken down in 1912 (QBM Memoranda 1910-25, typescript copy, 21).

3.8.21 In 1911 a contract was made with Alfred Jackson of Butley to carry goods by lorry and the firm's own horses were sold (QBM Memoranda 1910-25, typescript copy, 17). One consequence of this change was that by 1915, because of the weight of the vehicles, '*the pavement of the Stable yard became very uneven and rutty. A portion – both old setts and cobbles – was taken up and repaved with new and larger sett's purchased from Wetton's of Bollington*' (*op cit*, 47). The stable building, located on the south side of the mill cottage, seems to have been still standing in 1920 (*op cit*, 73) but was demolished by 1935-6 (Figs 10 and 174), and probably by 1923 (Table 9, no 2).

3.8.22 The clock in the stair tower of Old Mill was potentially installed by the 1890s or 1900s. An early photograph shows its place occupied by a circular window (Plate 4), and the earliest known mention of the clock is in July 1906 when it was repaired by the makers, Joyce of Whitchurch (QBM Memoranda, typescript copy, 205).

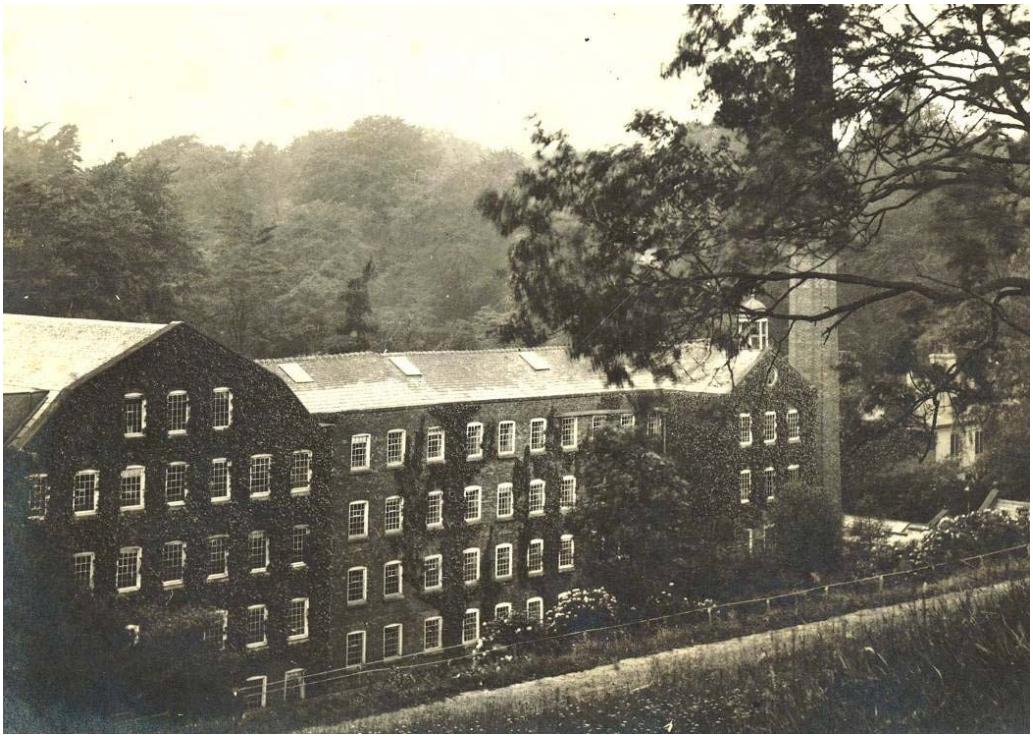


Plate 4: Front of the mill, c 1890s (QBM 3323)

3.8.23 Quarry Bank Mill fell into a steady decline during the 1920s. In 1939 Alexander Greg donated a large part of the estate, including the mill, to the National Trust, although limited production continued. In 1942, it was announced that Quarry Bank Mills Co Ltd was to be dissolved (*London Gazette*, 30 October 1942). This was implemented the following year under the Companies Act of 1929 (*London Gazette*, 2 February 1943).

3.8.24 Between 1930s to 1950, the work force declined from 178 to just 13, and floor space in the mill buildings appears to have been rented out to other businesses, such as the Hartford Storage Company (*London Gazette*, 21 May 1957). The textile business never recovered from this decline and production ceased in 1959.

3.9 1960S-2013 – THE MILL POST-CLOSURE

3.9.1 ***1960-1978:*** Quarry Bank Mill faced dereliction by the late 1960s, and between 1968 and 1976 over £240,000 was spent on its repair. This process of repair began in the late 1960s with the appointment of Kingham Knight Associates as architects, under whom initial works were carried out in 1969, focussing on the Old Mill and New Mill and involving the clearance of ivy, reroofing works and repair to rainwater drainage. Rainwater heads in the mill carry the date 1969, although not all were installed during this initial phase (Fletcher 2005, 101-3). The coping on the west side of Old Mill was rebuilt in about 1978 (QBM Drwg 1033/G/22, 23 and 78).

3.9.2 Stabilising works were carried out to the south gable of the large weaving building (1839 Weaving Block (Building E (Fig 79)) in 1973. This was being pulled out of true by the weight of the adjoining privy tower, and, as part of these works, the tower was reduced in height by the removal of the upper storey. Internally, in 1973-4 new stairs were then built against this south gable wall of the large weaving building, rising from the ground floor to the second floor (Fletcher 2005, 104; QBM Drwg 1033/40, 1033/45, 1033/37 and 38) (Figs 79-81). The old staircase at the north-west corner of the 1839 Weaving block was replaced in 1977, ahead of the opening of the mill as a museum in the following year (Fletcher 2005, 105; QBM Drwg 6361/01 and 02).

3.9.3 ***1978 Onwards:*** in 1980 the Quarry Bank Museum Trust acquired a new waterwheel, built in 1850 by William Fairbairn. This was a 100hp high breast-shot suspension wheel, similar to the wheel built for Quarry Bank Mill by Thomas Hewes, and was found in a state of decay at Glasshouses Mill in Pateley Bridge. The wheel, complete with its penstock, governor and gearing was removed to Styal where the process of installation in the wheelpit of the New Mill began in 1984. This work involved the manufacture of a number of replacement parts, including the shaft (the original now being on display in the car park at Quarry Bank Mill), sole plates and buckets. The rim gear was an unused spare found at Pateley Bridge, and a pinion wheel was acquired from a local scrapyard (Nixon and Hill 1987, 33-41). On 7 October 1986 the wheel turned for the first time (Quarry Bank Mill Trust Ltd 1986, 13).

3.9.4 Also in the New Mill, the stairway which descends from the fourth floor to the third floor, where it gives access to the covered gantry leading to former sizing room, appears to have been added between 1979 and 1989 (Figs 81 and 85).

3.9.5 In 1991-2 a transmission system was installed, allowing display looms placed in the weaving room in the Old Mill to be powered by the wheel (QBM Chronology; Quarry Bank Mill Trust Ltd 1993). During the same period, at the south end of the Old Mill an existing opening for a sliding door was widened and heightened to provide access to a viewing gallery in the wheelhouse. Stairs were also built to provide access from the basement of the Old Mill to the floor above the wheelhouse. On that floor, the cage surrounding the rope drive also dates from the early 1990s (QBM Drwg, Wheel Chamber Access, May 1991); the remains of the pulley system surviving on this floor were drawn in 1990 (Fig 77).

3.9.6 The installation of the waterwheel was followed in 1992 by the purchase of a steam engine of the same kind and approximate date as that installed at Quarry Bank Mill in 1836, this being a 20hp independent beam engine, built *c* 1840, which had been used to power a saw mill in Macclesfield. In 1993 the clearance of the former engine houses and boiler houses at the north end of the Old Mill began, prior to the area being archaeologically surveyed (QBM Chronology). In the same year the mill chimney was repaired and the missing capping was replaced (Quarry Bank Mill Trust Ltd 1993).

3.9.7 The Power Project, to restore steam power to the mill (Figs 88 and 89), was one of the National Trust Mercia Region's main fundraising projects for the Trust's centenary year in 1995, and in the following year the project was awarded £537,000 Lottery money (QBM Chronology). As part of the restoration of the 1836 engine house, former windows were opened and restored within the north wall of the Old Mill, and windows were replaced within the external walls of the engine house/boiler house range **(**NT, Report of Industrial Archaeology Liaison Group 1997). The 1871 boiler house was provided with a new brick superstructure and refurbished as an audio-visual theatre (QBM Drwgs 1603/05, 06 and 34) (Fig 90), and to the south of this a new underground boiler house was built to accommodate a gas fired boiler to supply the steam engine and heat the mill (QBM Chronology). The walls of the 1784 wheelpit were restored, complete with axle bearings, and the tailrace was also opened up and repaired. This required the removal of a wall built across the arch of the tailrace just beyond the wheelpit, and beyond this the partial rebuilding of the arch (QBM Drwg 1603.32; Allott and Lomax correspondence, 19 July 1997). The Power Galleries were officially opened in June 1998.

3.9.8 In 1999 a horizontal engine was acquired from the Jesse Street Dyeworks, Bradford. This has been restored and installed on the site of the horizontal engine at Quarry Bank Mill installed in 1871. In about 2002 a small Gilkes turbine was installed in the 1796 wheelpit as a demonstration exhibit (NT, Report of Industrial Archaeology Liaison Group 2002).

3.9.9 The ground floor of the large weaving building was first converted to a restaurant in 1982-3 (Quarry Bank Mill Trust Ltd 1983, 4; QBM Drwg P262/55/1) (Fig 83). Plans for that work instruct that the flags were to be taken up, stored and relaid on a screed over a concrete floor slab (QBM Drwg B230.S1, B230.BR1).

3.9.10 The interior of the building underwent a major refurbishment in 2002-3, creating the present arrangement of service areas at the south end and lobbies, toilets and stores at the north end. The service lift and passenger lift were also inserted as part of this scheme (QBM plans by Wiles and McGuire).

3.9.11 In 1980 the first floor of the small weaving building became the Styal Workshop, providing courses in crafts (Quarry Bank Mill Trust Ltd 1983, 1, 8). The toilets at the south end of this floor were added in 1982 (*op cit*, 2; QBM Drwg O262.5, B230.BR5) (Fig 83). On the ground floor, in 1981 an existing room at the south end of this building became the mill archive room and in the centre of the building partition walls were added to create the present arrangement of rooms (Quarry Bank Mill Trust Ltd 1983, 1; QBM Drwg 'Wheel Appeal Room/Proposed MSC Work Area Layout', July 1985; B243.01) (Fig 82).

3.9.12 The fireproof building (Building 4f on Fig 173) was taken over by Quarry Bank Mill Trust Limited in the late 1980s, having previously been leased by the National Trust to Styal Engineering (Quarry Bank Mill Trust Ltd 1986, 9). In the early 1990s the upper floor was partitioned for curatorial use and as a more suitable depository for the archive (Quarry Bank Mill Trust Ltd 1993). This conversion involved the creation of a corridor running the length of the east side of the building, giving access to a room in the southernmost bay and two larger rooms in bays 2-6 and 7-9 (QBM Drwg 829.1), At the same time, the jack arches were hidden by a false ceiling. The central room subsequently underwent further division to create the present arrangement.

3.9.13 The visitors' toilets in the former smithy and mechanics shop are presumed to have been created in the early 1990s when the wings of the stable block, which had been converted to visitors' toilets in the 1970s (Fig 80), were made into offices (QBM Drwg 820).

3.9.14 The shop was moved to the cloth warehouse in 1988 (Quarry Bank Mill Trust Ltd 1989, 9, 12), having previously been situated in the former lodge adjacent to the stair tower of the New Mill.

3.10 PREVIOUS INVESTIGATIONS

3.10.1 ***Pre-1990s:*** the earliest known recording of Quarry Bank Mill was the detailed architectural survey undertaken by David Lindsay in 1963, which included the Old Mill, New Mill and the fireproof building (Figs 56-60), and was accompanied by a written description with photographs (Lindsay 1963). Significant work was also undertaken as part of the East Cheshire Textile Mill Survey, culminating in the RCHME volume, published in 1993 (Calladine and Fricker 1993).

3.10.2 ***1990s Onwards:*** archaeological recording of the mill began in 1993-4 as a preliminary stage in connection with the proposed reinstallation of steam power. This work was undertaken by National Trust archaeologist Jeremy Milln and comprised a measured survey of the northern parts of the mill, including plans, elevations and cross-sections (Figs 61-69). One outcome of this work was the conclusion that the stair tower of the 1784 mill, although not bonded to the mill, was probably contemporary with its construction (Milln 1994). This work received the Association of Industrial Archaeology's Recording Award for 1994.

3.10.3 Following recommendations made by Jeremy Milln, a second phase of investigation was begun in 1994 by Greater Manchester Archaeological Contracts under Mark Fletcher. This work included excavation of the flywheel pit of the 1836 engine house (Figs 70-1), and trial trenching to determine the floor composition of the adjoining 1853 boiler house. In addition, trial trenching carried out within Old Mill located the infilled wheelpits of the 1784 mill and the 1796 extension. A proposal to trial trench the area between the Old Mill and the fireproof building for evidence of the early boiler was not carried out due to problems of access and spoil removal (Fletcher 1995).

3.10.4 These works were followed in 1995-6 by the excavation of the wheelpit of the 1784 mill by Ron Fitzgerald of Structural Perspectives (1998) with the assistance of the mill's engineering department (Figs 72-4). Fragments of timber were found within the base of the wheelpit and carried axe marks suggesting that the wheel had been broken up in situ. This wheel appears to have been a compartmented breast-shot wheel of 18ft diameter and 14ft width with staggered buckets, and to have been modified during its working life, '*apparently with the addition of a large segmental spoke-mounted gear wheel*'. However, much of the evidence of the bearings had been removed during late twentieth-century reflooring works (NT, Report of Industrial Archaeology Liaison Group 1997). At about the same time, a total station survey was carried out of the headrace and tailraces, and was tied in with the survey of the north end of the mill in 1993-4 (*ibid*). Further recording of the wheelpit in the 1796 extension was carried out in 2002-3 (Figs 75-6).

3.10.5 In August 2007 trial trenching was undertaken by the South Trafford Archaeological Group ahead of the construction of a new pathway on the west side of the manager's house. This work revealed brick footings of the stable building erected in 1877 and demolished in the early twentieth century (Faulkner and Pierce nd).

3.10.6 In 2008 Carolanne King, the National Trust's Assistant Archaeologist North West, carried out a rapid photographic survey in connection with repairs to the base of the north wall of the Old Mill where this was exposed within the flywheel pit of the 1836 engine house (National Trust 2008).

3.11 TIMELINE OF KEY EVENTS IN THE DEVELOPMENT OF QUARRY BANK MILL

3.12 Presented below are the key documented events in chronological order that contributed to the development of Quarry Bank Mill. Where pertinent the buildings or components are linked either to the Lost Buildings map (Fig 174) or the phase plan for the complex.

YEAR	KEY EVENT
1784	The land was leased for the construction of Quarry Bank Mill
1784	The Old Mill was constructed along with the first wheel pit (Fig 173: **1a**)
1792	The water wheel was replaced
1796	An extension was constructed to the south side of the Old Mill (Fig 173: **2a**). The Old Mill was raised by a single floor, and a second wheel pit was added and incorporated the first iron wheel. Also added were a privy and hoist tower to the west of the extension.
1798	Quarry Bank House was constructed
1800-1	The present weir was constructed by Peter Ewart
1800-1	Possible installation of a 10hp engine ?
1803	Quarry Bank House was remodelled
1803	The construction of the stables
1807	Replacement of one of the two water wheels in the Old Mill
1807	The construction of a cotton warehouse (Fig 174)
1810	Earliest confirmed installation of a 10hp engine and the installation of a wagon boiler
1810	Construction of Scutching Room (Fig 174)
1816	Construction of tailrace tunnel
1817	Start of construction of the New Mill (Fig 173: **3a**)
1818	Construction of a water wheel in New Mill
1819	Completion of the New Mill (Fig 173: **3a**)
1822	Removal of two water wheels in the Old Mill
1822	The Waste and Mixing / Making Up rooms were in place by this date (Fig 174)
1824	Construction of the Mill Managers House
1832	Robert Hyde Greg took over the running of QBM
1830-4	The construction of the workshops (Greg Rooms Range) (Fig 173: **3c**). It was first depicted on a map of 1834
1835	New engine house / boiler house constructed (Fig 173: **4a**)
1836	Central Weaving Shed constructed (1836 Weaving Block) (Fig 173: **4b**)
1836	A 20hp independent beam engine was installed
1839	By 1839 an extension to the 1836 Weaving Block had been constructed (Fig 173: **4c**)

YEAR	KEY EVENT
1839	Construction of southern weaving shed (1839 Weaving Block) (Fig 173: **4d**)
1843	Construction of Preparation Block, replacing the Scutching Block (Fig 173: **4f**)
1843	Installation of a 31hp boiler from Boulton and Watt, which was installed in an extension to the west of the engine house (Fig 173: **4e**)
1845	Construction of the cloth warehouse to the north of the stables
1853	Construction of a boiler house to the east of the engine house (Fig 173: **4g**)
1855	A pair of gantries were constructed linking the New Mill and the Greg Rooms to the weaving sheds
1864-5	A retort house and gas holder were installed by Kays of Bury
1870	Edward Hyde Greg took over the running of QBM
1871	Provision of 101 new looms
1871	A 60hp horizontal engine was installed to provide power to the weaving rooms
1871	A new boiler from Hick Hargreaves and Co of Bolton was installed in a new boiler house (Fig 173: **5a**)
1875	New chimney constructed by Edward Barlow of Stockport (Fig 173: **5b**)
1875	Privy block added to the south of the 1839 Weaving Block
1876	A new two storey extension was added to the south end of the workshops – Greg Rooms Extension (Fig 173: **5c**)
1877	A new stable building was built to the south of the former manager's house
1880	The boiler in the 1853 boiler house was replaced with one by Thomas Oldham of Stockport
1885	An upper floor was added to the main workshop (Fig 173: **3c**)
1889	An economiser from Greens of Wakefield was established to improve efficiency of the engines
1894	Remedial work undertaken to the three storey weaving shed (1839 Weaving Block) (Fig 173: **4d**)
1895	A glass roof was constructed over the Mill Yard
1890s	A clock was installed in the Stair Tower
1900	Robert Alexander Greg took over the running of QBM
1904	72 second-hand looms from Cressbrook Mill were installed in the Old Mill
1904	Two turbines (200hp and 20hp) were installed in the 1796 wheel pit
1904	An agreement was made with Wilmslow and Alderley Gas Co for the supply of gas
1906	The 1836 beam engine was sold for scrap
1907	A second hand 60hp engine was installed by Marshall and Sons of Gainsborough

YEAR	KEY EVENT
1909	84 Northrop looms were installed
1914	44 further Northrop looms were installed
1939	Alexander Greg donated part of the estate to the National Trust
1943	Quarry Bank Mill Co was dissolved
1976	Quarry Bank Mill Trust Ltd was set up
2000-1	National Trust took over the running of the site

4. QUARRY BANK MILL FABRIC DESCRIPTION

4.1 INTRODUCTION

4.1.1 The following sections provide a summary of the results of the inspection and analysis of Quarry Bank Mill. The first part provides a descriptive account of the building; outlining details of the plan, form, power train and function, commencing with the external elements, followed by the internal details. Following this descriptive account of the historic fabric, an analytical discussion of the phasing of the structure, linked into the historical evidence, and also the wider context of the mill to place it within its historical, architectural and cultural context.

4.2 OLD MILL SPINNING BLOCK

4.2.1 The main block is a rectangular structure of five stories aligned approximately north-south, and comprises 18 x 2 bays, measuring 39.14m by 9.3m with an internal area of 38.76m by 8.3m (Figs 95, 100-1, 108-9, 116-7, 123-4, 128, 132, 139, 140, 143, 144, 154-8). The structure is known as the Old Mill, even though only the north-eastern 27.34m comprise the original mill, with the south-western 11.8m forming a subsequent extension, the joint of which is visible as a slight narrowing of the walls at their junction (Fig 103; Plate 5). The walls are of hand-made, mould-thrown brick to two-brick thickness (0.46m) in the original north-eastern part of the block, narrowing by a skin to 0.35m wide in the later south-western extension (Figs 116 and 117). Both phases of the structure comprise four-stretcher English Garden Wall bond (Plate 5).

Plate 5: Joint between Old Mill and the extension

4.2.2 Windows are provided to each bay, and are typically are 1.07m wide, with shallow camber-arched lintels and projecting dressed sandstone sills (Plate 5). Each houses a 20-light timber framed windows, probably representing similar replacements of the original fenestration. The present pitched roof is of Welsh slate, behind parapet walls on the long elevations, rebuilt above the lintels of the upper floor windows (Plate 6; Figs 143 and 144).

Plate 6: The eastern facing elevation of the Old Mill Spinning Block

Plate 7: External stair tower, with circular clock and octagonal cupola bell tower

4.2.3 The external stair tower, set two bays from the northern end of the structure on its western side (Figs 108-9, 143 and 168), was of similar construction, and appears to have formed part of a continuous and contemporary build. It measures 7.4m x 4.2m and comprises three bays to its western facade (Plate 7). The upper three floors had 20-light timber framed windows to each bay, matching those within the main mill, but with a continuous lintel band at first-floor level (Fig 146; Plate 7). This overlay a closed pediment above a central doorway at lower ground-floor level, flanked by a further pair of windows, with the architectural detailing being further embellished with a projecting sandstone string to the coped gable, which housed a circular clock, below an octagonal cupola bell tower (Plate 7), both of which are still functional.

Plate 8: Bull-nosed spine wall in staircase

4.2.4 The tower originally housed a timber stair, but this was subsequently replaced with a sandstone block staircase in the southern bay (Fig 117), with a central spine wall and flagstone half-landings, each lit by a window. The spine wall was bull-nosed to each landing, with a round-headed arch above a chamfered impost carrying the landing above (Fig 123; Plate 8).

4.2.5 The documentary evidence suggests that by 1822 at the latest, the tower housed a fire-fighting stand pipe, although that extant in the south-west corner represents a replacement, probably being of early or mid-twentieth century date (Plate 8). The tower was much larger than required for the half-turn stone stair, with the northern two bays partitioned with what appears to been an original full brick-thickness wall, to form an approximately square chamber on its northern side, with two windows in the south-eastern wall, and one in the north-eastern wall, although these were largely obscured by the subsequent erection of a large chimney immediately to the north-east (Fig 143). The chamber is accessed at each floor level through a timber batten door. At each floor level, the northern part of the stair tower is presently used for storage, with much of the space being filled with files and boxes, potentially obscuring detail within the wall faces. However, a slender vertical rope pulley, comprising two cables, and pulley wheels mounted on the third floor ceiling (Fig 128), is visible at second- and third-floor level, within timber plank shuttering in the north-east corner of the tower (Figs 124 and 128). The timber floors are carried on east/west-aligned timber joists, of similar size to those within the main body of the Old Mill, without the need for ceiling beams.

4.2.6 Three small towers project from the north-western elevation of the Old Mill (Figs 115-7, 154-5). The northernmost measures 3.26 x 1.15m, and actually represents two structures; the northern part comprising the remains of a square-section chimney, reduced to the height of the adjacent tower in the late nineteenth century. The structure on its southern side has a clear butt joint with the chimney (Plate 9), showing it to be an earlier feature; the chimney was added *c* 1810, when water power was deemed insufficient to power the mill in times of low water (*Section 3.7.7*). The earlier tower has replaced doorways to each floor, and probably represents an original privy tower, being devoid of fenestration, apart from a small square aperture on its upper floor (Fig 154).

4.2.7 At the northern end of the extension of the Old Mill, adjacent to the corner of the thirteenth bay, a 0.99 x 1.22m tower projects into the courtyard. It has what appears to be a doorway in its western external face at lower ground-floor level (Plate 10; Fig 154-5), with dressed sandstone jambs, which form the side walls; this has been blocked latterly, and a single light window inserted.

4.2.8 Internally, the tower is open through to lower ground-floor level. Whilst this would suggest an external lower ground floor entrance, possibly into a hoist tower, the lower level of the tower is very similar in style to the soil collection aperture in the base of a large dry shoot toilet tower attached to the 1835 block at Brooks Mill, Congleton (Calladine and Fricker 1993, 83), clearly demonstrating it to be its pre-cursor, and forming the base of a privy tower, placed at the south-western corner of the original mill.

4.2.9 A further tower, placed 1.91m to the south, adjacent to the extension of Old Mill, butts its external face, and is clearly a later addition. It has a blocked, arched, aperture in its north face at ground-floor level, possibly representing an original soil access to the base of a further privy tower, which was almost certainly erected after the construction of New Mill in 1818-19. The tower was clasped by wall ties at lower ground and first-floor levels (Plate 11), with the space between the two towers being infilled at second-floor level, to form a larger privy at a later date (Plate 7).

Plate 9: Chimney abutting a possible privy tower

Plates 10 and 11: Tower at the southern end of the Old Mill (left). Privy on second floor (right)

4.3 OLD MILL: LOWER GROUND FLOOR

4.3.1 The lower ground floor has been heavily refurbished and strengthened, retaining little original fabric, other than the external walls and wheel pits. The extant flagstone floor has almost certainly been relaid, probably re-using original material, comprising mixed sizes of pale sandstone flags. At each bay division, 0.45m x 0.26m brick piers have been inserted, to support the ends of 0.20m x 0.10m I-section steel beams, which replaced the original timber ceiling beams; these are bolted onto central I-section stanchions of 0.16m section (Fig 101). The I-beams support 60mm thick timber rails that carry replacement 90mm longitudinal ceiling joists.

4.3.2 The eastern long elevation has been rendered internally, obscuring early detail, but presumably affording the structure protection against the damp of the hillslope, into which the wall is partially cut, and from potential seepage from the headrace tunnel, that runs parallel to the external face of wall, in a culvert below ground level (Figs 95, 101 and 143).

4.3.3 Each bay of the east wall, to the south of the projecting stair tower, retains a 1.16m wide window aperture, placed at ceiling height, and extending to a similar depth, with heavily sloping sills and reveals, maximising the ingress of light from 0.88m² fixed 12-light timber windows (Plate 12). In the third and fourth bays from the southern end (OMLG15 and 16) of the extended Old Mill, however, these windows have been remodelled to form a 2.82m wide horizontal window above the inserted water turbine, which was installed in an earlier wheel pit (*Section 3.7.8*; Figs 99 and 100). This comprises three four-light timber window frames, the central section having a removable upper portion, and with internal cast-iron pipe mullions above the stepped rendered sill (Plate 13). The apertures of the west elevation typically comprise 1.16m wide four-light fixed timber windows with flat, timber-plank sills, placed 0.65m below ceiling level.

Plate 12: Fixed 12 light timber windows

4.3.4 The northern bay (OMLG1) has a blocked central aperture of 1.1m width, below a timber lintel, which had a 0.74m wide flue inserted into its lower northern side, and which was blocked subsequently (Plate 14), but probably linked the 1853 boiler to the original chimney which lay on the opposite side of the wall to the south-west at the southern end of the original power plant (Figs 12 and 174). A 0.15m diameter water pipe was also inserted through the wall above the aperture (Plate 14).

Plate 13: Four-light timber window frames

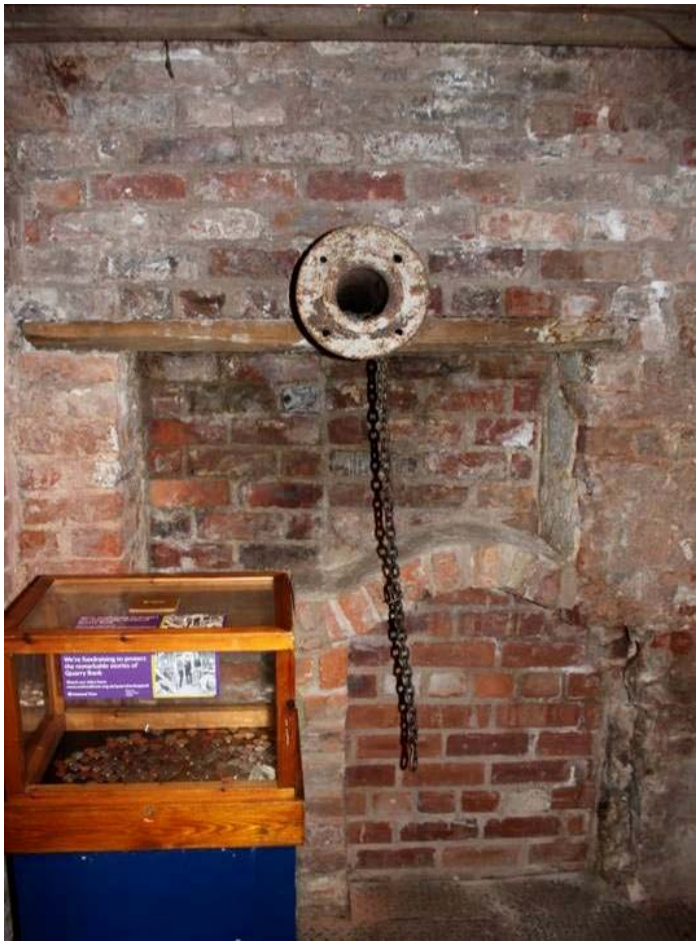


Plate 14: A water pipe, inserted through the wall above blocked aperture

4.3.5 The adjacent bay (OMLG2) retains a 1.1m wide repaired doorway in the west wall, now affording access into a courtyard (Fig 101), but which previously formed the access to the earliest engine house that was added to the external side of the mill in this position. A further blocked aperture of similar size in the bay to the south (OMLG2) probably represents the blocking of an original window by the addition of the power plant. The west wall of the fourth and fifth bays from the northern end of the mill (OMLG4 and 5) lay behind the square-section chimney and adjacent tower, and were therefore without openings. However, the fifth bay (OMLG5) had an inserted cast-iron bearing box of 0.54 x 0.62m size inserted to the south of the square section chimney, above a narrow 0.34m wide hand-made brick-blocked aperture above a 0.04m thick sandstone sill, which may have represented a narrow original opening to the south of the inserted chimney, possibly forming a narrow window.

4.3.6 The sixth bay (OMLG6) retains a timber 36-light casement window, with 160 x 125mm panes, which may represent a survival of the original fenestration of the mill (Plate 15). Its internal timber lintel was replaced with concrete rails during the restoration of the lower ground floor. A window in the thirteenth bay (OMLG13) has similar panes, placed within a fixed frame with wide timber mullion. The windows between these two bays, with the exception of that in the eighth bay (OMLG8), were blocked or obscured. Bay 15 (OMLG15) houses a 1.24m wide doorway, which appears to have been inserted, as it has a blocking for an apparent extended sill on its northern side.

Plate 15: 36-light casement window, which was possibly a survival of the original fenestration

4.3.7 The south wall of the extended Old Mill had a 1.53m wide doorway inserted into the New Mill, affording late access to the wheel pit therein (Figs 98 and 99). A 0.3m width of modern brick blocking on its western side, however, suggests that it replaced an earlier, possibly original, window. To the east of the doorway, the wall had a low-level archway above the driveshaft from the New Mill water wheel, which was clearly inserted during its construction in 1818. A shallow rebate in the wall above for a bevel gear has a cast-iron lintel, and appears to have been remodelled, and has two approximately 0.45m wide blocked bearing boxes to either side, which are now concealed within a Perspex casing around the drive and upright shafts.

4.3.8 The north wall of Bay 1 (OMLG1) formed the original external wall of Old Mill, but subsequently became a partition to the second engine house (Fig 101). A 1.01m wide doorway was inserted at its western end, with threshold steps up into the engine house, and a large, 0.85m wide, arched cast-iron bearing box was inserted 1.21m from the eastern end of the wall, to carry the drive shaft from the engine (Plate 16). This was placed only 1.35m above floor level, in order to connect to the bevel gear against the south wall.

Plate 16: Large arched cast-iron bearing box

4.3.9 The east wall of the second bay from the northern end (OMLG2) houses a modern gas manifold, probably in a reduced cellar-light window, whilst the two bays to the south (OMLG3 and 4) overlay the headrace of the original wheel pit. A 3.3m wide, 1.77m high, basket arch was rebated one brick (0.23m) into the wall thickness (Plate 17), and housed a 0.3m wide batten door affording access into the headrace. This door was flanked by a 0.61 x 0.70m un-glazed window aperture, presently containing vertical iron bars, which afforded light from the mill into a large flagged chamber beneath the stair tower which gave access to the headrace tunnel (Plate 18). The mouth of the headrace was recessed only 0.15m below floor level, and comprised dressed sandstone blocks, with a chamfered lip into the similarly constructed ashlar block wheel pit (Plate 19). This had sandstone plinths to either side, with that on the western side being significantly wider, at 0.6m width (Fig 101). The side walls, carrying the axle mounting have been rebuilt, with no evidence for original power transmission. The eastern side of the extant ashlar block side walls were set on a curve of approximately 2 inch less diameter than the wheel itself (Plate 20). The wheel would have been an breast-undershot wheel, with power almost certainly being taken directly from the axle on its southern side.

Plate 17: Basket arch rebated into the wall thickness

Plate 18: Large flagged chamber beneath the stair tower giving access to the headrace tunnel

Plate 19: Ashlar block wheel pit

Plate 20: Extant ashlar block side walls

4.3.10 The tailrace was the full width of the wheel pit, and this width continued beyond the external wall of the mill, comprising a shallow basket-arch brick vault above a dressed sandstone plinth of between 0.61m and 1.21m height, according to the water level indicator on the tailrace face (Plate 21). The tailrace appears to have been remodelled several times, with a north/ south aligned wall placed across it 4.2m from the wheel pit, and directly beneath the eastern wall of the Engineering Shop, to the west of the narrow courtyard (Fig 101). This housed a shallower, narrower, brick-blocked arch in its northern side (Plate 22), with an extant narrower, lower, culvert in its southern side (Plate 23) carrying the tailrace below the western range of buildings to a dressed sandstone opening into the River Bollin, which was set within an arch of similar width to that of the eastern part of the tailrace (Plate 24). A longitudinal support wall of 1.8m length was also inserted into the larger, eastern part of the tailrace, presumably to support the external wall of the mill above. It was placed on two channel-section iron beams, forming an I-beam, and these are presently supported on late brick piers (Plates 22 and 23).

4.3.11 The turbine of 1905 was installed within the reduced wheel pit of a second wheel installed within the second bay from the northern end of the extension to the Old Mill (OMLG15) in 1796 (*Sections 3.4.3 and 3.7.8*). It also comprised dressed sandstone blockwork, similar to that used in the original wheel pit to the north, although several of the blocks from the southern pit wall appear to have been used to house the inserted turbine (Plate 25), with the southern wall of the wheel pit being rebuilt in brick. There is presently no access to the pit, and the modified headrace is obscured.

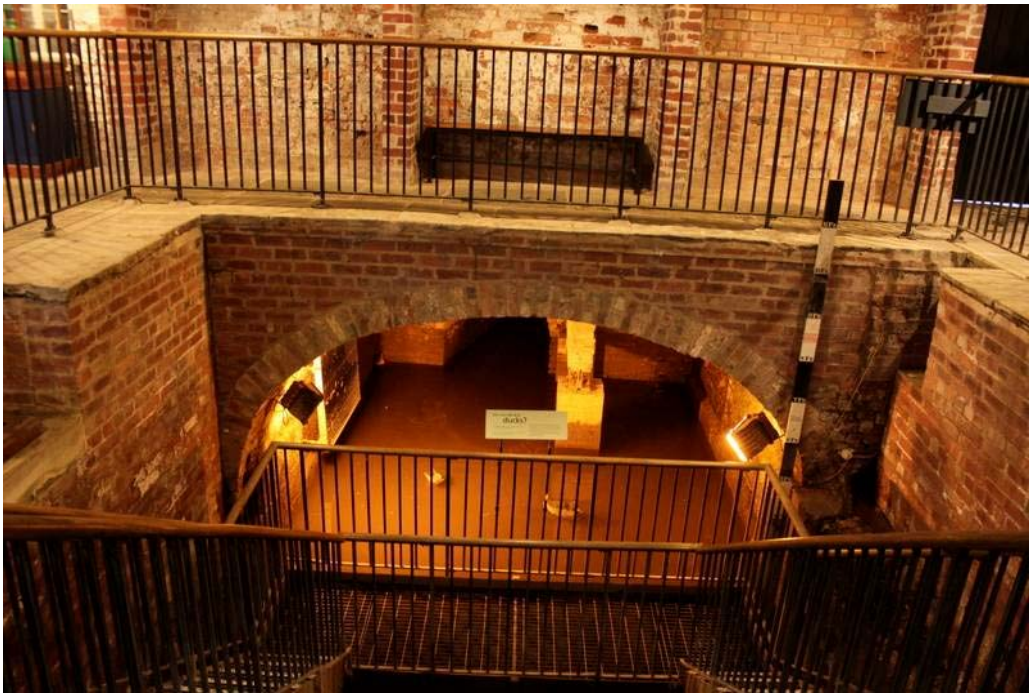


Plate 21: Tailrace face with water level indicator to right

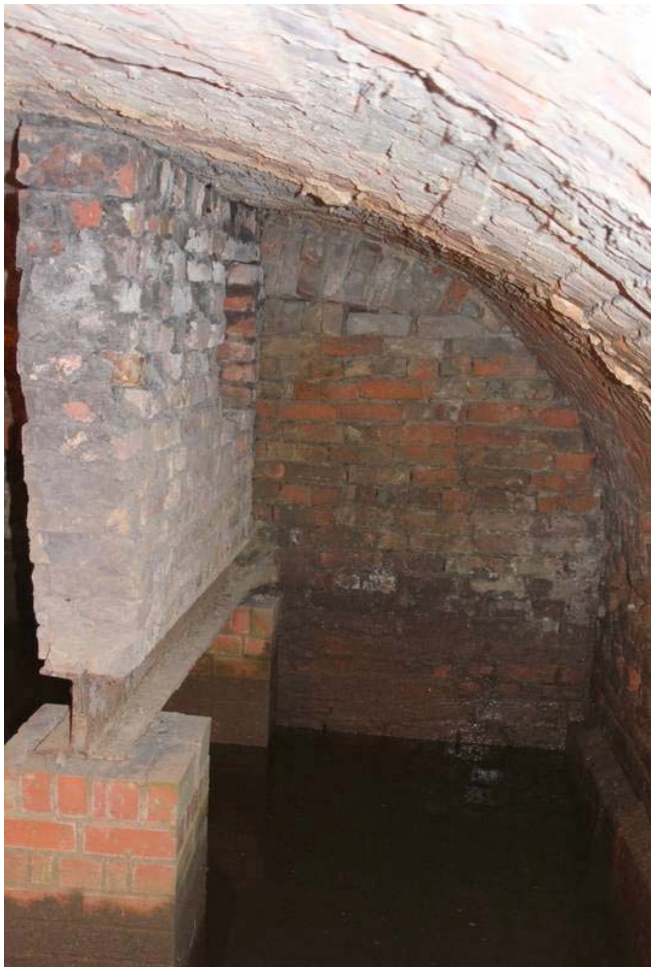


Plate 22: Narrower brick blocked arch

Plate 23: Extant narrower, lower culvert with longitudinal support wall

Plate 24: Arched outfall at the eastern end of the tailrace

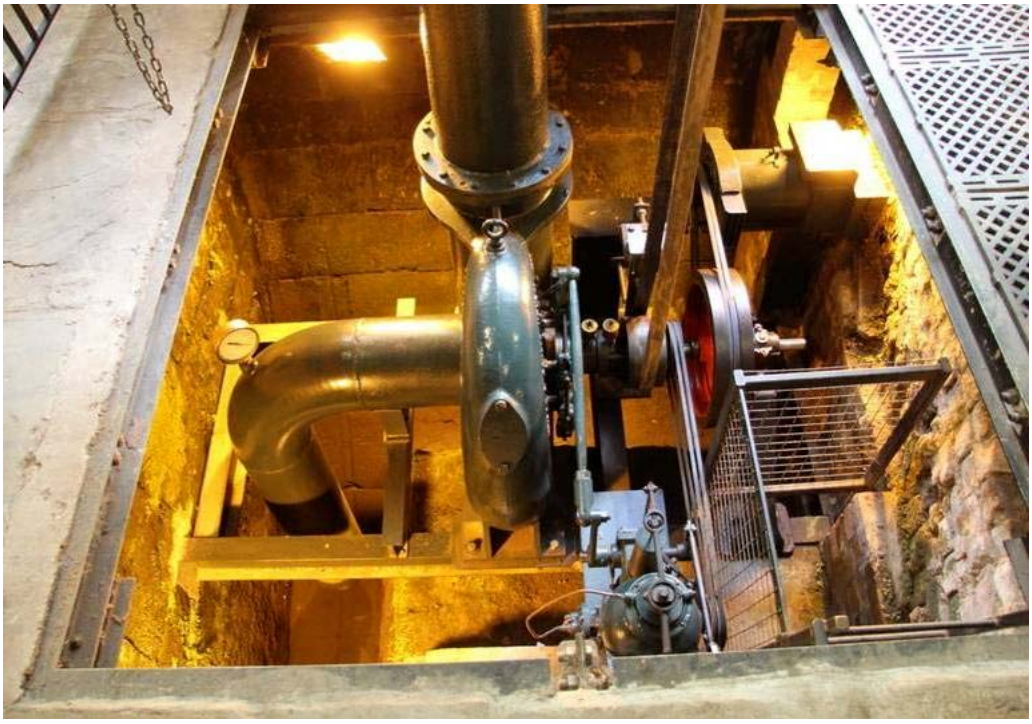


Plate 25: Dressed sandstone block-work housing the inserted turbine

4.4 OLD MILL: GROUND FLOOR

4.4.1 The ground floor of the Old Mill is arranged in a similar fashion to the lower ground floor, but with access provided from the stair tower at the northern end of the east wall, through a replaced timber batten door at the northern end of its southern bay (Figs 108 and 109). External access into the northern chamber of the stair tower, denoted as a Lodge in the insurance plan of 1822 (*Section 3.3.3*), was a designed feature of its construction. All apertures into the external towers of the west wall have also been blocked, with much of the west wall being internally rendered.

4.4.2 The window apertures to each bay at ground-floor level are typically 1.71m high, with bull-nosed brick reveals, and with timber lintels and internal stone sills. The 1.37m high 20-light window frames sit on chamfered stone blocks above the sill, and have a removable section, comprising the central two panes in the second from top row (Plate 26).

4.4.3 The floor comprises heavily worn, 1.33m wide timber planks (Plate 27), which almost certainly remain from the productive life of the mill, but are unlikely to be original.

Plate 26: 20-light window frames

Plate 27: Ground floor general view

4.4.4 Although heavily strengthened during the refurbishment of the complex in the late twentieth century, the ground floor retains its original ceiling beams (Plate 27). These comprise large-scantling, 0.21m wide timber ceiling beams, spanning the width of the mill at each bay division, although many are obscured by metal sheeting, which formed a rudimentary type of fireproofing. This is continuous across much of the ceiling, above some extant lath and plaster ceiling (Plate 28), which almost certainly pre-dated the metal sheeting as the original form of fire-proofing. The 70mm wide rafters, placed on approximately 0.41m centres, are only exposed in the eastern part of northern three bays (OMG1, 2, and 3); the western part of the ninth and tenth bays (OMG 9 and 10), and the whole of the thirteenth bay (OMG13), which marks the division between the two phases of construction, and is slightly wider than the others, at 2.45m, compared to a typical bay width of *c* 1.90m. Late I-section steel flitch plates brace the western part of the second beam (OMG2/3), with the fourth beam (OMG4/5) having both a timber corbel, and channel-section flitch plates to either face at its western end (Plate 29).

4.4.5 The timbers retain many bolt holes and scars, although several relate to cast-iron, channel-section hangers for strengthening, I-section beams, which are still present across the sixth, eighth and eleventh bays (OMG6, 8, and 11; Figs 108-9; Plate 30). However, bolt hole pairs in the soffits of all but the ninth, fourteenth and fifteenth beams, several accompanied by semi-circular gouged drum scars on the beam faces, demonstrate the position of a line shaft, placed approximately 2.9m from the eastern wall (Plate 31). Similar evidence, including drum scars on the third and fifth beams (OMG3/4 and OMG 5/6), was observed for a further line shaft, placed 2.1m from the western wall. Pairs of bolt holes, set 0.41m apart on the soffits of the southern four beams (OMG14/15-OMG17/18), centred approximately 1.5m from the east wall, potentially suggest an offset short shaft. This may have provided the primary driveshaft to the floor from the upright shaft in the southern bay (OMG18).

4.4.6 Two substantial bevelled timber mounting plates are attached to the ceiling within the twelfth bay (OMG12; Figs 107-8). Both have aligned bolt holes, but their function remains unclear, presumably relating to a machine installed in this bay. A similar bracket in the southern bay (OMG18; Plate 32), is aligned with the upright shaft, but its transverse alignment suggests that it was not directly related to a bevel gear on the upright shaft, which would have been more substantial, and almost certainly housed within the adjacent wall face. A doorway to New Mill was inserted adjacent to the upright shaft (Fig 106), with a heavily rendered patch of wall on its western side, providing the only possible evidence for the position of a bevel gear bearing on the upright shaft in this position. However, an extant 0.91m square bearing box was inserted between New and Old Mills, placed 1.8m from the west wall, and was aligned with the soffit bolt holes of the western line shaft. The western timber pad in the twelfth bay (OMG12) is aligned, as is a further timber pad on the soffit of the eleventh beam (OMG11/12), and possibly suggests the translation of power through bevel gears across the floor at this point.

4.4.7 The ceiling beams are carried on later replacement columns throughout the ground floor (including Old Mill and Old Mill Extension) (Figs 107-9), comprising I-section riveted stanchions with similar cross member and angled braced in the third and fifth bays (OMG3 and 5).

Plate 28: Extant lath and plaster ceiling

Plate 29: Late I-section steel flitch plates bracing the western part of the second beam

Plate 30: I-section beams, still present across the sixth, eight and eleventh bays

Plate 31: Gouged drum scars on the beam faces, indicating position line shaft

Plate 32: Bevelled timber mounting bracket in the southern bay aligned with the upright shaft

4.5 OLD MILL: FIRST FLOOR

4.5.1 Original access was provided onto this floor from the northern stair tower via a 0.86m wide timber batten door in the fifth bay (OMF5) of the eastern wall (Fig 117). Further access was inserted subsequently through a doorway from the later New Mill of 1818-9, placed adjacent to the return of the gable wall, and was possibly within an original window aperture in the 1796 extension of Old Mill. It presently houses a 1.86m x 1.28m cast-iron, sliding fireproof door (OMF18), positioned 0.54m above the floor level of Old Mill, at the level of the higher floor in the New Mill. A narrow, 0.47m wide timber batten door, covered with metal fireproof sheeting, afforded access into the tower in the thirteenth bay (OMF13), with a full-height, 0.74m wide, timber folding door that afforded access to the privy tower in the adjacent bay.

4.5.2 Towards the northern end of the west elevation in Bay OMF4, the projecting rectangular tower is presently used for storage, and is accessed through a modern plywood door (Figs 154 and 155). The northern part of the structure comprises the remains of the original chimney, and is partitioned from the tower to the south by a brick wall placed to the north of the doorway from the mill (Fig 117). The adjacent tower has had two wall stubs added internally, presumably framing a door at some time, but presently with an open entrance into the tower.

4.5.3 The window apertures to each bay at first-floor level are typically 1.71m high, with bull-nosed brick reveals, and with timber lintels and internal stone sills. The 1.37m high 20-light window frames sit on chamfered stone blocks above the sill, and have a removable section, comprising the central two panes in the second from top row.

4.5.4 The ceiling is carried on similar ceiling beams to those on the floor below, again spanning the width of the block, and socketed into the external brick walls, although the apertures are obscured by thick layers of white-wash and paint, obscuring the detail of lintels or sills. The beams are generally clad in metal sheeting obscuring much of the detail. However, many bolt holes and cut-outs remain visible on the soffits and faces of many of the beams. These provide an indication of the principal drive shafts, which are otherwise not extant. A row of aligned pairs of bolt holes are visible on the soffits of the fifth to seventeenth beams from the north end of Old Mill, several of which are placed within cut-outs. These clearly represent the position of a line shaft, placed *c* 2.98m from the east wall, just to the east of the centre of the mill (Figs 115-7).

4.5.5 The southern ceiling beam (OMF17/18) also has two bolt holes in a rectangular cut-out in its soffit to the west of centre, aligned with an upright shaft bearing in the north-western side in New Mill, and two horizontal loop bolts projecting from the north face of this beam, align with further bolt holes in soffits of the fifth to the sixteenth beams, marking the position of a further line shaft, placed 2.43m from the west wall.

4.5.6 Other sets of bolt holes, but not necessarily reflecting the main shafts, are also represented (described from north to south). The penultimate beam from the northern end of the mill (OMF2/3) has two pairs of bolt holes in its soffit at its eastern end, which appear unrelated to any other bolts. The adjacent beam to the south has a wide gap in the metal sheeting across its central section, but is devoid of features, whilst that to the south (OMF4/5) is supported at its western end by a projecting timber corbel, that is 1.4m in length and fastened to the original failing beam with bolts and steel plates. Similar timber corbels were also inserted under the western ends of the eight and ninth beams (OMF8/9 and 9/10; Fig 116). The tenth beam has more substantial steel flitch plates to either side (Fig 116), spanning from 0.15m from the east wall, for a length of 5.15m.

4.5.7 The fourth beam from the north (OMF4/5) also has a worn groove in the soffit, adjacent to the corbel. The fifth beam from the north retains a metal bracket with two projecting bolts at its western end, with the adjacent beam having two pairs of horizontal bolt holes through both faces at its western end, a further pair to the east pierce only the southern face of the beam, and two further pairs, placed to the immediate east of centre-line towards the eastern end of the beam, solely pierce the northern face. The seventh beam (OMF7/8) has a similar groove to that of the fourth beam, worn into its soffit at the western end. Two pairs of horizontal bolt holes span the full width of the beam to the east, with a third pair placed further to the east and placed only on the northern face of the beam, which also has a round-headed iron bolt in the centre of the northern face. The beam to the south (OMF8/9) has a similar central bolt, and a pair of horizontal through-bolt holes adjacent to its timber corbel, with a similar pair towards its eastern end. The eleventh beam also has a central, large round-headed iron bolt, and also has two cut-outs at the western side of its southern face. The adjacent beam has a pair of horizontal bolt holes through it, and towards its western end, which are aligned with a pair of bolt holes on the thirteenth beam. The second beam from the southern end (OMF16/17) has an additional single bolt hole in the soffit towards its western end, with the adjacent beam to the north also having a single bolt hole at the west end, a groove worn into the beam to the east of centre, and the scar of a cut-out at its eastern end.

4.5.8 The ceiling beams are supported by a row of cast-iron columns, offset slightly to the west of the centre line of the mill (Plate 33). The columns are 2.34m high, with varying thickness of timber pads to the ceiling beams (Figs 116-7) and are of only 62mm diameter. These unusually narrow columns appear to represent insertions, suggesting that the original floor was open, and that the ceiling beams, spanning the 8.6m internal width of the mill, were unsupported. The columns comprise separately cast, or possibly wrought, solid cylindrical section shafts, which are socketed into identical head and foot-plates; they measure 0.40 x 0.15m, and have a longitudinal shallow rib between bolt holes at either end, and are of uncertain date, but the slender nature of the castings, and the use of large, circular-sawn timber pads to the beam soffits, suggests a late date of insertion. The column between the fourteenth and fifteenth bays (OMF14/15) is slightly offset to the east of the column line (Fig 116).

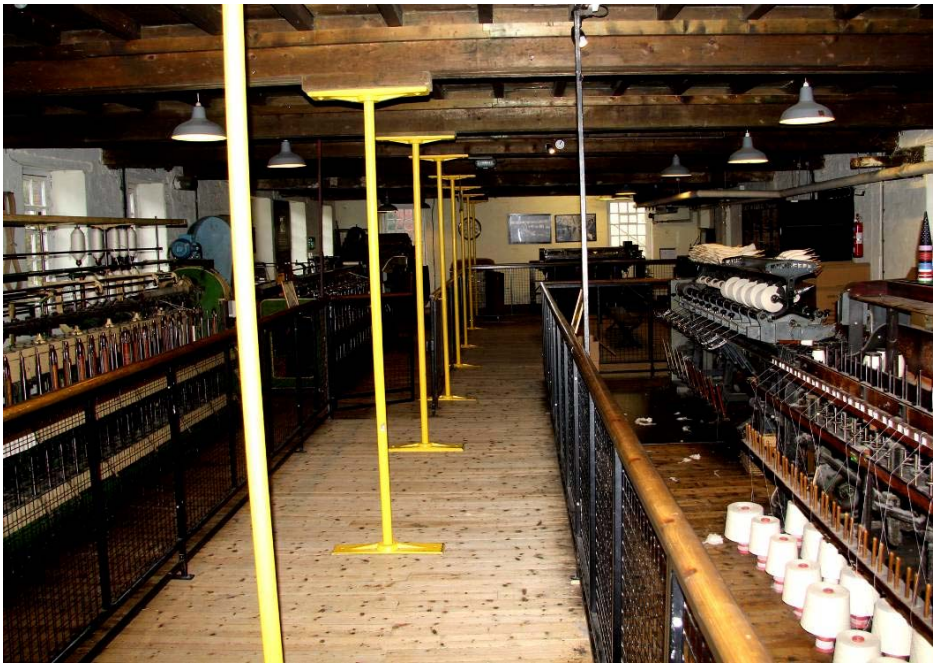


Plate 33: Interior of the first floor, looking north, showing the beam and column arrangement

4.5.9 An additional column, comprising a steel I-section stanchion, was placed on the centre line of the mill, immediately to the south of the second beam from the north (within Bay OMF3) (Fig 117). It supports the eastern end of a horizontal beam of similar section, which spans to the west wall, and carries two perpendicular beams, placed immediately below the level of the ceiling beams, spanning to the north wall. Three further transverse short lengths of I-section steel beam form the frame for a relatively late overhead hoist within the north-western corner of the room. Further evidence for strengthening of the structure survives in the form of three wrought-iron tie rods, which span the building, two flanking the northern ceiling beam, with the third placed on the southern side of the beam between bays nine and ten (OMF9/10) (Fig 117).

4.5.10 A metal sheet-clad timber beam, placed perpendicular to, and suspended below, the ceiling beams of the second to sixth bays (OMF2-6) was placed adjacent to the east wall (Fig 117). This may also represent bracing of the ceiling beams. A more conventional timber trimmer beam was placed between the southern two beams adjacent to the western wall.

4.5.11 At the southern end of the extended mill, two square-section, cast-iron columns, placed adjacent to the south wall are also associated with the present water-powered transmission system (Fig 116). A timber beam, placed between the two southernmost beams, immediately to the east of the centre line of the mill, is carried by two associated, smaller cast-iron square columns.

4.5.12 Approximately 2m from the east wall, the upright shaft of the extant power transmission system ascends from the ground floor (Fig 115). This is capped with a bevel gear, translating the power to a short line shaft spanning the southern two bays (OMF17 and 18). This retains a belt drum in the penultimate bay, which, linked to a similar drum placed on a further extant line shaft, is placed on the centre line of the structure, spanning the southern six bays, and with rope wheels placed beneath each beam.

4.5.13 Belt drums also survive to the north of the southern beam (formerly linking it to the primary drive shaft), and between the fourth and fifth beams (Fig 117), within a timber safety guard. The fourth and sixth beams have hangers carrying the line shaft. Offset 2.44m to the east, and overlapping the southern shaft by a full bay, a second line shaft powers the southern shaft via a belt between the two shafts placed on drums in the fourteenth bay (OMF14) (Fig 116). This longer shaft runs longitudinally from the seventh to the fourteenth bays (OMF7-14), carried by hangers on the soffit of each beam. It retains extant drums in bays seven, nine (OMF7 and 9) and eleven to fourteen (OMF11-14), many retained timber safety guards, and with that in bay nine retaining a belt to power a further line shaft in the northern part of the structure. An extant open-web wheel also survives on the line shaft, within bay eleven (OMF11). The northern of the two shafts, powered from belts on this shaft, extends from bays twelve to seven (OMF12-7), and is offset only 0.40m from that in bays thirteen to eighteen (OMF13-18). It again has hangers to each beam, with drums in the seventh, ninth, eleventh and twelfth bays (OMF7, 9,11 and 12).

4.5.14 At the northern end of the mill a further short length of line shaft is aligned with that on the eastern side of the first floor, and retains a drum at its southern end within the northern bay (OMF1) (Fig 117). The shaft projects through a 0.91m wide cast-iron bearing box, with arched lintel, placed within a blocked window, and beyond the northern wall of the mill, where it terminates in a large, open-web rope wheel (Plate 34) presumably providing power directly from a rope within the engine house below. A rectangular frame of cast-iron beams, within the ceiling above the line shaft within the northern bay (OMF1), were presumably inserted to brace the structure at this point.

4.5.15 The ceiling is of timber planks, but is now mostly obscured by metal sheeting, which formed rudimentary fireproofing. The tenth, eleventh, thirteenth and eighteenth bays (OMF10, 11,13 and 18) retain no sheeting, exposing the 70mm wide, rectangular-section rafters, placed on approximately 0.35m centres. In the northern bay (OMF1) there is a rectangular timber block with four bolts attached to the ceiling. To the immediate north-west, a rectangular hole in the ceiling has been blocked with metal sheeting. A further, smaller timber block, housing two bolts, lies to the north-west, and has four bolt holes piercing the metal sheeting on its northern side (Fig 117). A similar timber block, with six bolts, is attached to the ceiling, to the north-west of the centre of the third bay (OMF3). A large block in the bay to the south (OMF4) was placed on the northern side of the bay, to the east of the centre line, and houses a pair of bolts at either end, and four in the centre. On the southern side of the same bay, a smaller timber pad houses six bolts, and was presumably related. Two rectangular ceiling hatches were placed in the ninth bay (OMF9; Fig 116) and were blocked subsequently with metal sheeting.

Plate 34: Spoked rope wheel on the exterior of the northern wall

4.5.16 The ceiling of the penultimate two bays (OMF16 and 17) retains large timber pads with square bolts at each corner, and four bolt holes in the centre (Fig 115). The adjacent bay (OMF15) houses two smaller, offset timber pads on the ceiling, that have been placed 0.4m apart, and each retaining two projecting bolts (Fig 115).

4.5.17 The floor comprises similar boards to the ground floor below, with a trap door to the ground floor in the thirteenth bay (OMF13), on the western side of the mill (Fig 116), adjacent to the original hoist tower.

4.6 OLD MILL: SECOND FLOOR

4.6.1 Access is provided into this floor from the stair tower close to the northern end of the eastern elevation, via a 0.85m wide timber batten door, placed within Bay OMS5 (Fig 118 and 124), and from the later, four-storey New Mill to the south, is via a fireproof door located in the western end of the southern wall (Fig 123). A door in the fourth bay (OMS4) affords access to the northern external tower of the west wall, with a blocked aperture into the original chimney to the north. A further 0.79m wide timber doorway affords access into the extended privy tower, in the fourteenth bay (OMS14), beyond the south-west corner of the original structure.

4.6.2 Each bay not covered by a projecting tower has a centrally-placed window in the long elevations, comprising 15 to each wall (Fig 123). The northern gable wall houses two further windows, placed 1.12m from either end of the wall internally. A blocked aperture in a corresponding position in the southern wall represents a similar window that was blocked, or possibly remodelled to a doorway and blocked subsequently, following the addition of New Mill. The wider aperture at the western end of the wall, however, represents the window being remodelled into an extant doorway. This houses a 1.99 x 1.59m cast-iron, sliding double fireproof door, placed 0.54m above the floor of Old Mill, at the floor level of the later New Mill to the south-west (Fig 122), and is flanked by two tie-rod plates. A 0.62 x 0.4m brick-blocked cast-iron frame, recessed into the south wall between the fire door and the corner of the block, is placed too low to represent a partially infilled bearing box, and is more likely to be the housing for a fire hose reel.

4.6.3 The window apertures are typically 1.71m high, similar to those at first-floor level, and also with bull-nosed brick reveals, and internal timber lintels and stone sills. The 1.37m high 20-light window frames, sit on chamfered stone blocks above the sill (Plate 35), many having a removable section, comprising the central two panes in the second row from the top.

4.6.4 The ceiling is carried on 17 transverse beams, as in the floors below, forming the divisions between each bay. These carry slender 72mm rafters, which are visible in all but the six southern bays (OMS13-18), where they are obscured by metal sheet cladding, which formed rudimentary fire-proofing. The second, fourth to seventh and fifteenth beams from the northern end of the mill, are constructed using three narrower vertical timber beams bolted together, below a slightly wider horizontal timber beam (Figs 122-124). These presumably form replacements of the original beams. The ceiling beams are supported by a row of cast-iron columns that were offset 0.71m to the west of the centre line of the mill (Figs 122-4). Each is 2.30m high, from floor to beam, with the majority comprising 50mm diameter cast-iron, hollow cylindrical columns with a flat 610 x 140 x 35mm head plate, with two bolts into the soffit of the beam (Plate 36). The head plate has a 110mm astragal and 160mm reinforcing ribs. The column foot forms a mirror of the capital, being bolted to the beam below. The columns below the ninth, tenth, fifteenth and seventeenth beams are later replacements, and comprise plain, narrow cast-iron columns with a rectangular, 0.3m long head plate. As at first-floor level, many of the ceiling beams bear evidence for the attachment of brackets associated with the power system.

Plate 35: 20 light window frame sitting on chamfered stone blocks

4.6.5 A row of aligned bolt hole pairs placed 1.83m to the east of the column row, and, mainly within two small rebates, are visible on the soffits of the first, third, eighth to, fourteenth, and sixteenth beams. A further four pairs of bolt holes, two within rebates, are also aligned along the western side of the room on the underside of the eighth to the eleventh beams (Fig 123), suggesting the position of another line shaft. The northern and ninth beams (OMS1/2 and OMS 9/10) have a timber corbel beneath them at their eastern ends, projecting from the wall and are attached with two steel brackets and four bolts (Plate 36). The second beam (OMS 2/3) has a T-section cast-iron corbel below its eastern end, presumably representing an earlier attempt at beam support. The third beam has a pair of bolt holes in its western soffit, a large iron bolt and square plate in its northern face at the east side, and a rectangular scar in its southern face further to the east. At the eastern end of the fifth beam, a trimmer runs below it along the east wall within Bay OMS6, with a short timber beam projecting from its northern side, attached to the end of which is a cast-iron plate (Fig 124).

4.6.6 The eighth beam (OMS8/9) has a square rebate and a single bolt hole in its soffit, to the west of the column, and also has two pairs of bolt holes in the soffit, to the east of the column and two small square scars in its southern face (Fig 123). The ninth beam has a square cut-out housing a square iron bolt at its western end (Fig 123), and a single separate bolt in its soffit to the west of the column. To the east of the column is a further square rebate in the soffit. A wrought-iron tie beam runs along the southern side of this beam, bracing the original structure. The ninth and tenths beams (OMS 9/10 and 10/11)are supported by a corbel and two brackets at their eastern end, whilst the eleventh beam (OMS11/12) has a similar supporting corbel with two brackets at its western end (Fig 123). It also has an angled rectangular rebate and a pair of bolt holes in a further rectangular rebate to the east of the column, with three rectangular scars on its north face, between these two features (Fig 123). The adjacent column (OMS12/13) has matching scars on its southern face and similarly placed bolt holes in the soffit to those on the beam to the north (Fig 122). The thirteenth beam (OMS13/14) has three horizontal bolt holes running through it, to the east of the column, whilst the fourteenth, sixteenth, and southern beams have supporting timber corbels to either end. To the west of the column the fourteenth beam (OMS14/15) also has two rectangular scars in its northern face, and a slightly larger rectangular cut out in its south face. To the east of the column, three iron bolts project from its southern face. The sixteenth and southern beams (OMS16/17 and OMS17/18) have an iron bolt in the northern face, to the west of the column, and a bolt in either face to the east. The southern beam also has a pair of horizontal bolt holes above its timber corbel at the western end. To the east of the column, it retains a further iron bolt with an iron washer.

4.6.7 The floor comprises timber boards with a 2.75 x 1.75m trapdoor in the thirteenth bay (OMS13), placed in the western side of the building, 0.75m from the external wall, and directly above that on the first floor (Fig 123).

Plate 36: Cast-iron columns on second floor of Old Mill

4.7 OLD MILL: THIRD FLOOR

4.7.1 Original access was again provided solely from the external stair tower, through a doorway on the northern side of the landing. Further access was subsequently provided through a 1.28m wide, sliding timber door, clad with metal fireproof sheeting, and inserted centrally into the south wall, following the erection of New Mill in 1818-19. A narrow, 0.57m wide timber batten door in the third bay of the west wall (OMT3), also afforded access into the original external privy tower (Figs 126, 127 and 128).

4.7.2 The window apertures differ from those below, being slightly shorter (1.48m). They house similar frames to those on the floor below set 0.31m within the apertures comprising 20-light removable timber windows. Windows are provided to each bay, although not above the southern privy and hoist towers of the west wall, possibly suggesting that these have been reduced in height, although there is no internal evidence for a reduction in the towers. Two extant windows survive in the northern gable, with a blocked window clearly visible in a similar position on the western side of the south wall (Fig 126). A similarly blocked window was almost certainly placed at the eastern side of the wall, but is obscured by later render.

4.7.3 Unlike the lower floors, ceiling beams do not span each bay division. Instead, beams of similar scantling to those below, form the tie beams of nine trusses, which differ between the original and extended parts of the Old Mill. In the earliest part of the mill, the seven trusses comprised king post trusses, with steeply-angled wing braces to the centre of each pitch, below a collar which clasps the king post, and is trenched into the face of the principal rafter (Plate 37). Several of the trusses exhibit both scored assembly marks (Plate 38) and chiselled numerals (Plate 39), on their upper, southern faces. In the extended mill, the two southern trusses are queen strut trusses (Fig 128; Plate 40), where the vertical post support the principal rafters, with a collar set higher than would be the case of a straining beam of a queen post truss, where the posts directly support the purlin. These were tenoned and iron bolted to both the tie beam and the principal rafters, and had outwardly jowled feet, housing angled braces (Plate 40). Several of the trusses had smaller outer princess posts, which appear to have been inserted to strengthen the trusses at a later date. The principal rafters carry two cleated, butt-ended purlins to each pitch and a central ridge purlin of similar scantling. The area between the upper purlin and the ridge is greater than that below, and each pitch houses four skylights, each measuring 1.1 x 1m. These retain 24-light timber, with the upper and lower rows being shorter.

4.7.4 The first, second and fourth tie beams from the northern end of the Old Mill have timber corbels beneath their western ends (Fig 128; Plate 37), similar to those on the floors below, and are jointed by steel bolts and plates, with similar corbels also present at the eastern ends of the first and fifth tie beams. The majority of the beams also retain metal sheet cladding, forming basic fire-proofing, with many of the trusses also being clad above the collar (Plates 37 and 40). The internal pitches of the roof are plastered, obscuring the rafters, with some bays also having metal sheet cladding above the plaster lining (Plate 40).

Plate 37: King post trusses in the early part of the mill

Plate 38: Scored assembly marks cut into southern faces of the trusses

Plate 39: Chiselled numerals on the southern faces of the trusses

Plate 40: Queen strut truss with metal sheet cladding forming basic fire proofing

4.7.5 Despite the cladding, several features are visible on the tie beam soffits. The first, second, fifth and sixth beams have pairs of bolt holes, set 0.37m apart, and placed immediately inside the eastern queen struts, 3.15m from the east wall (Figs 127 and 128). This clearly represents the position of a line shaft, typically offset from the centre line, and was almost certainly placed to power transversely-arranged spinning mules.

4.7.6 The northern beam also has a single bolt hole in the soffit, 1.39m from the east wall, but this appears unrelated to any other features. The third beam has two, 0.34m square cut outs in its soffit, one on either side of the centre, and three bolt holes running horizontally through it above the eastern corbel. The fifth beam has three horizontal through-bolt holes towards its western end, with three at either end on the adjacent beam to the south and the eighth beam. The seventh beam has two notches, possibly for joists, in its northern face, whilst the two southern beams have a more regular arrangement of lapped joist sockets (Fig 128; Plate 40), suggesting that this end of the mill had a loft at some point.

4.7.7 In the bay adjacent to the stair tower (OMT4), two additional trimmer beams form a rectangular frame in the ceiling. This forms the base of a stair within the roof space, affording access to the clock, in the gable above the stair tower. Three wrought-iron tie rods span the third floor at tie-beam level, placed on the northern side of the third and sixth trusses, and across the southern face of the fifth beam. A modern timber quarter-turn staircase affords access to an inserted mezzanine floor above the southern bay (OMT18) (Plate 40), which also provides access to the fourth floor of the New Mill, via a fireproofed timber door.

4.7.8 In the south-west corner of the mill, at the western end of the south wall, a 0.57m square cast-iron frame is rebated 0.27m into the wall, 0.87m above floor level (Fig 127; Plate 41). This is similar to that on the floor below, and almost certainly housed fire fighting equipment.

Plate 41: Square cast-iron frame, possibly used for fire fighting equipment

4.7.9 The floor comprises timber boards as below, although no trap door to the second floor was visible during the survey, possibly being obscured by display sets. A modern timber ramp in the southern bay (OMT18) leads up to the doorway in the south wall, affording access to the higher floor within the later New Mill.

4.8 OLD MILL: FOURTH FLOOR

4.8.1 At the northern end of the Old Mill is a further mezzanine floor in the three end bays (OMFO1-3) (Plate 42; Fig 168). It retains trusses similar to those to the south within the original part of the Old Mill, with the slender king posts clasping the ridge within a birds mouth joint (Plate 42). The floor of this attic, which is of timber planks, is accessed by a narrow stair leading up from the north-eastern stair tower. The narrow stair was a later insertion and the implication is that the mezzanine was not an original feature. Although, it has a single 16-light window, set centrally within the northern gable, this was not necessarily intended to illuminate the mezzanine floor.

Plate 42: Mezzanine floor at northern end of the Old Mill

4.8.2 The late stair also affords access to the roof of the northern stair tower (Fig 132). This is internally rendered, with a lath and plaster covering to the rafters forming the framing to three narrow rectangular skylights (Fig 132; Plate 43). This small loft houses the mechanism for the clock in the external gable (Fig 143; Plate 7), which comprises an extant clockwork mechanism, housed within a timber frame (Fig 132; Plate 43), and bearing a memorial plate to Arthur Greg, suggesting a date of *c* 1890.

Plate 43: Clock mechanism and framing in the Old Mill stair tower

4.8.3 Immediately above the clock mechanism, the roof is capped with an ornate cupola (Fig 143; Plate 7). This is of typical Georgian style, comprising eight vertical columns set on a leaded octagonal base, presumably of timber construction, and placed behind the parapet wall across the ridge of the stair tower roof (Fig 132; Plate 7). The columns carry an octagonal leaded dome, capped with a finial, and with rolled lead ribs to each segment (Fig 143; Plate 7). Horizontal timber framing within the cupola carries the lower, and smaller of two bells, the upper hanging within the dome.

4.8.4 At the southern end of the extended Old Mill, the final bay of the roof houses a timber-framed mezzanine floor, with an internal area of 8.68 x 4.24m (Figs 129, 131-2). The rafters within this roof space are mainly obscured by metal sheeting, covering a bituminous material behind. The floor comprises timber plank boards, now partially covered with a blue-grey linoleum. Access is afforded from a fireproof door from the New Mill, up a short stair, and from a modern timber staircase form the third floor below.

4.9 NEW MILL: LOWER GROUND FLOOR

4.9.1 The lower ground floor of New Mill almost entirely comprises the water wheel in its 1818 wheel pit (Fig 98, 167 and 169; Plate 44). The wheel is of spoked, cast- and wrought-iron construction, and is a later insertion (*Section 3.9.3*). Its wheel pit is obscured by the extant wheel, which has an external rim gear, powering an *in-situ* drive shaft into the Old Mill to the north (Plate 45).

4.9.2 The side walls of the pit are of dressed sandstone block, with stone steps affording access to the northern axle from both the western side, via a stone-flagged landing, (Plate 46) leading to a 0.71m wide doorway from the courtyard (Plate 47). To the east access was afforded from a quarter-turn stone stair (Plate 45), leading to a further arched doorway in the re-entrant angle between Old and New Mills, which was blocked subsequently (Fig 98; Plate 48). Access to the southern axle was through a timber trap door within the flagstone floor (Plate 49).

4.9.3 The western external wall housed a wide open arch to the courtyard, above the wheel pit, allowing maximum light into the chamber. It presently houses a frame of iron bars (Plate 47), which probably replicates the original infilling of the large opening. A round-headed doorway to the south affords access to the southern side of the wheel, from the courtyard to the west, via a flight of four sandstone-capped brick steps. The area immediately to the south of the door was enclosed within a brick wall, forming an internal hoist tower, which was powered by a line shaft running along the south-west wall, and retaining both a bevel gear, and the brackets for a further wheel, translating the power from the floor above (Plate 50). A substantial cast-iron corbel carried the end of the line shaft, and was attached within a rebate in the south wall, which originally housed two round-headed cellar-light windows, which were subsequently brick-blocked. The east wall to the south of the wheel pit was similarly rebated above a 1.07m high plinth, which appears to have had a structural role, having a large brick buttress at its northern end at its return into the headrace.

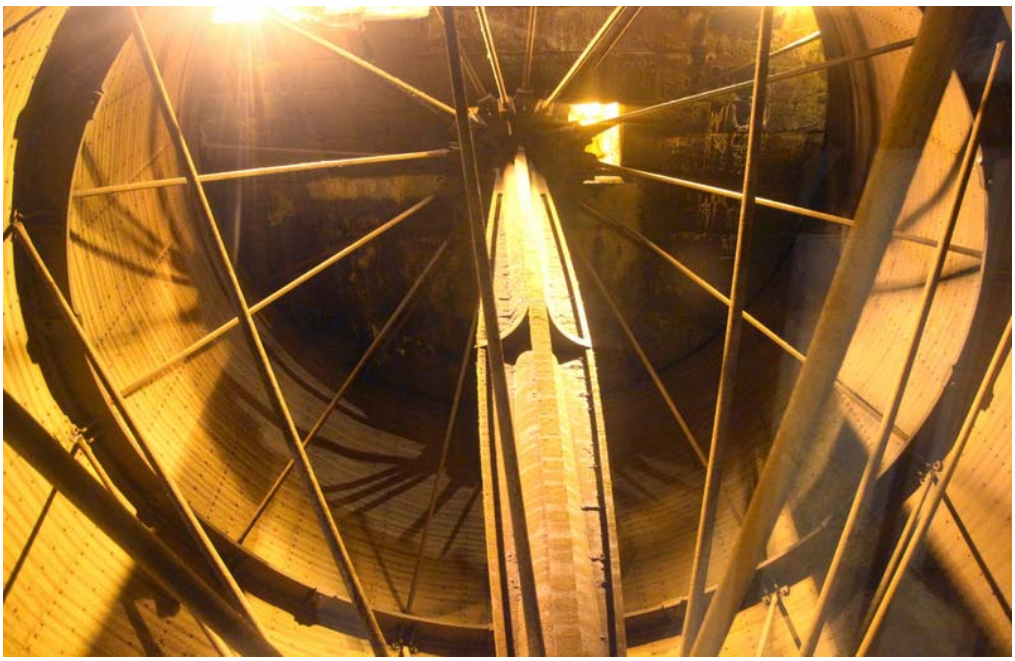


Plate 44: Interior of the present water wheel

Plate 45: Rim drive gear taking power off the water wheel

Plate 46: Steps leading down to the axle on the north side of the wheel

Plate 47: Doorway from the courtyard providing access to the steps on the north side of the wheel

Plate 48: The blocked arched doorway at the re-entrant angle between the Old and New Mills that formerly accessed the wheel chamber

Plate 49: Access to the southern axle was via a timber trap door

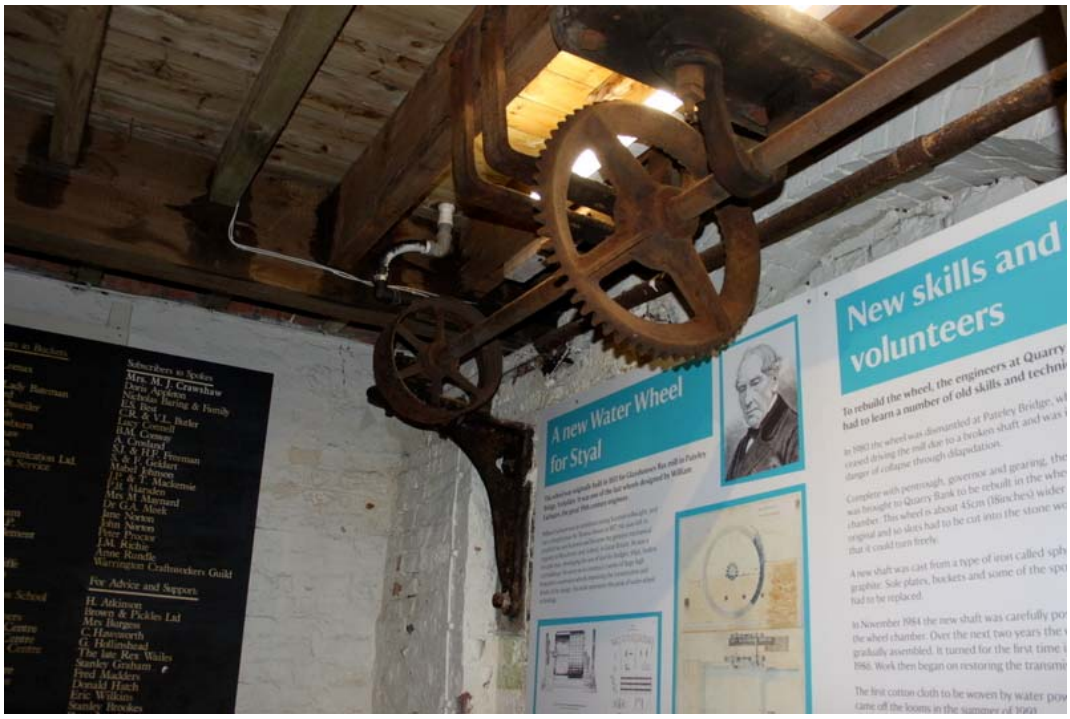


Plate 50: A line shaft along the south-west wall, with bevel gear and belt wheel translating power from the floor above

4.9.4 Much of the primary power system associated with the wheel has been refurbished, including the flow control shutters placed within the headrace, and controlled by levers at ground-floor level. The northern side of the wheel pit retains a rim wheel, mounted on the extended axle plinth, with a tooled rebate into the wheel pit wall face to allow it to rotate within the perimeter of the wheel rim (Plate 45). Its axle formed a short primary motion shaft, which housed a much larger flywheel, recessed within a sandstone block-lined wheel pit within the floor. A smaller pinion wheel then offset the shaft through the wall of the Old Mill, to a bevel gear, which powered an upright shaft, housed on a large cast-iron bracket carried on replaced modern brick piers. The horizontal drive shaft was aligned with that in the north-west wall of the Old Mill, although set at a lower level, suggesting that another bevel gear and clutch lay to the north of that extant.

4.9.5 As with the lower ground floor in the Old Mill, extensive remodelling has taken place during the refurbishment of the mill, with the insertion of a steel frame, and new timber joists to the ceiling. However, several original elements survive, including four large timber beams, which span the wheel pit, and carried ground-floor joists over the pit, allowing maximum floor space to be used above. The southern three beams, were carried on 127mm diameter cast-iron columns, with an additional column comprising a length of 0.15m diameter water pipe being inserted below the southern end of the central beam. The columns have similar capitals and head plates to those above, suggesting they formed part of the original construction.

4.10 NEW MILL: GROUND FLOOR

4.10.1 The New Mill of 1818-9 is of 7 x 7 bays and aligned approximately east-west. It measures 17.54 x 14.26m, with an internal floor area of 16.73 x 13.54m. It is of hand-made, mould-thrown brick construction, with walls of 1½-brick thickness (0.37m) in three-stretcher English Garden Wall bond. The two long elevations have windows, similar to those in the Old Mill, one in each of the seven bays to all but the upper floor which houses three windows within the gable of the mansard roof (Figs 103, 106, 145-6, 159-61; Plate 51). The windows continue onto the northern façade, where it projects three bays beyond the Old Mill, with all windows being placed approximately 0.5m above the height of those in Old Mill. On its southern face, the new structure incorporated an external stair tower, measuring 4.39 x 2.61m, rebated 1.3m from the south-eastern corner of the structure (Fig 106; Plate 51).

4.10.2 This was described as being of stone construction in a plan of 1822 (QBMA108), and is of similar style to the stair now present in the Old Mill (*Section 4.2.3*). It also houses a water pipe for fire-fighting in its north-western corner (Plate 52), and projects above the parapet of the adjacent mansard roof, having a short timber passageway into the upper floor (Plate 51). The tower incorporates two windows to each landing of the southern side of the structure (Plate 51), comprising narrower 10-light timber frames below brick camber-arched lintels and with projecting sills, similar to those of the mill.

4.10.3 In the second bay of the south wall of the new mill is a 1.54 x 1.83m contemporary privy tower at its western side, with a similar sized hoist tower immediately to the east (Fig 106). Both are shown on the insurance plan of 1822 (Fig 11), with the hoist being replaced subsequently. The privy tower is internally blocked on each floor, but retains small external timber vents to each floor in its south elevation. The fenestration of the south wall of the New Mill appears to have comprised 20 light windows in the western bay (NM1) to the west of the privy tower, and 20 and 25 light windows in the three bays between the privy and stair towers (NM3-5; Plate 53).

Plate 51: The gable elevation of the New Mill, with mansard roof, has similar windows to those of the Old Mill, with one in each of the seven bays apart from the upper floor

Plate 52: Within the north-western corner of the stair tower was a water pipe for fire-fighting

Plate 53: The south wall of the New Mill with privy and hoist towers

4.10.4 Internally, the ground floor of the New Mill presently has a large opening in the floor, above the mouth of the headrace. This would have been covered in the original construction, allowing full use of the floor space. The ceiling is carried on north/south aligned 0.16m wide ceiling beams, carried on 0.12m diameter hollow, cylindrical cast-iron columns with long shallow ribs to a flat head plate. These are typically 2.29m in height, with a 602mm by 178mm top plate of 24mm thickness, with a 66mm diameter 62mm high capital housing the 40mm thick ribs. This has a 38mm thick collar, placed 110mm above a 26mm thick simple astragal. The column foot comprises two circular plinths, one 34mm thick and the lower 22mm thick, to a flat base plate.

4.10.5 Each beam, which has a narrow chamfer to the soffit, spans the entire width of the structure, supported at one-third intervals by the columns. Each bay to each elevation has 20-light timber windows, all removable, with many having tilting top rows (Plate 54). Doors in the south wall afford access to the external stair tower, and to a hoist tower, with an inserted doorway between affording access to a raised gantry to the Greg Rooms. The adjacent beam on its western side has a projecting convex sandstone corbel (Plate 55), whilst that to the west has a substantial timber corbel inserted beneath, strengthened with tie rods (Plate 56).

Plate 54: Each bay has 20-light timber windows, including tilting top rows

4.10.6 The bay to the west of the hoist tower (NMG1) is also spanned by a closed-web, whale-backed T-section beam (Plate 54), which aligns with pairs of projecting bolt holes in trimmers, placed 0.75 and at a further 2m intervals to the north (Fig 106), and also with a bearing box placed in the external face of the north wall of the Greg Rooms (Fig 105; Plate 57), demonstrating the power transmission into the ground floor of the Greg Rooms. A large gouge in the soffit of the adjacent ceiling beam to the west (NMG3/4), at the northern end of this bay, coincides with a massive cast-iron bracket in the ceiling and forms clear evidence for the housing of an upright shaft; this had appropriate bolt holes for the attachment of bevel gears to translate the power to the ground floor (Plate 58). One bay to the west of the upright shaft (NMG2/3), and level with it (Fig 106), a cast-iron J-shaped bracket (Plate 59), bolted to the soffit of the ceiling beam carried a shaft towards the western wall, and had an additional column placed on its northern side, to further strengthen the structure. A short length of shafting against the western wall has a rope drum at its northern end (Fig 106), suggesting that it was not part of the same power system, and probably represents a museum insertion, although the associated J-shaped and open-web brackets, mounted on short timber pads (Fig 106), similar to those observed in Old Mill, may be contemporary with the mill's power system.

Plate 55: The convex sandstone corbel supporting the beam on the western side of the mill

Plate 56: A timber corbel has been inserted under the eastern side of the beam, supported by tie-rods

Plate 57: The bay to the west of the hoist tower has a bearing box placed in the external face of the north wall of the Greg Rooms

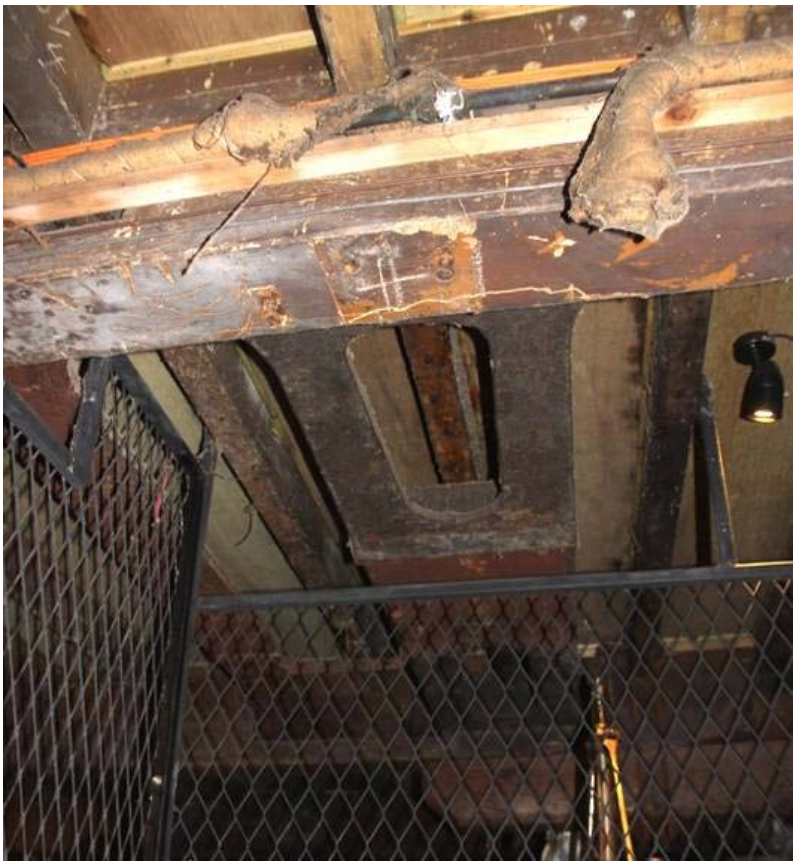


Plate 58: A large cast-iron bracket in the ceiling would have accommodated an upright shaft to take power to the ground floor

Plate 59: To the west of the upright shaft housing, a J-bracket carried a shaft towards the western wall

4.11 NEW MILL: FIRST FLOOR

4.11.1 The first floor is of similar form to that below, comprising seven bays, with north/south aligned ceiling beams carried on two rows of six, hollow, cylindrical cast-iron columns, of similar style to those below (Figs 111, 114-5). The window apertures of the first floor are 1.71m high and 1.07m wide, with bull-nosed reveals, as in the Old Mill, but have timber sills with timber lintels, unlike the stone sills of the Old Mill. The window frames are similarly 1.37m high, housing 20-light windows with similar opening panels to those in the Old Mill, either replicating their style, or possibly just forming part of a refenestration of the entire building. The eastern window of the south wall was remodelled to form a doorway, with that into the privy tower on the south wall also being blocked and obscured by render. The adjacent window in the south wall was also brick-blocked during the insertion of the wider hoist tower (Plate 60).

4.11.2 Access to the New Mill was originally from doorways inserted into the gable wall of the earlier Old Mill to the north, and via a 0.94m wide timber batten door into a contemporary external stair tower, erected on the south-western corner of New Mill (Figs 114-5). The later hoist tower is accessed through a 2.03m by 1.48m sliding timber door below a steel I-section lintel.

4.11.3 In the bay adjacent to the stair tower (NMF5) a 2.42 x 1.07m timber door affords access to a 1.56m wide, covered raised walkway, leading to a 1.22m timber batten door into the later Greg Rooms to the south. The ceiling is carried on six, large-scantling north/south aligned beams as below, supported by two rows of identical columns to those on the ground through third floors (Plate 61).

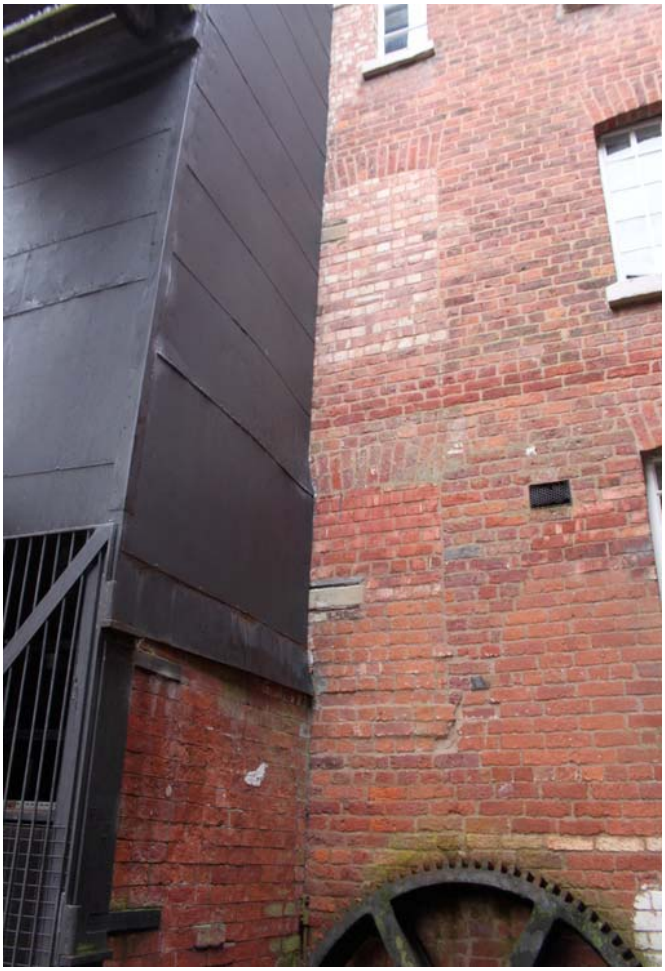


Plate 60: A window in the south wall was brick-blocked during the insertion of the wider hoist tower

Plate 61: The second floor of the New Mill is carried by six north/south-aligned beams, supported by cast-iron columns similar to those on the other floors

4.11.4 Three inserted timber trimmer-beams span the southern part of the central bay (NMF4; Fig 114-5). Each retains an aligned pair of bolt holes in the soffit, suggesting the position of a line shaft directly above that on the ground floor.

4.11.5 The western ceiling beam has a pair of bolt holes in a rebate in the soffit at its northern end. Immediately to the north of its centre, are a pair of horizontal bolt holes running through the beam, with two identical holes aligned in the adjacent beam (NM2/3). A further two pairs of horizontal bolt holes run through the western beam at its southern end, also mirrored in the adjacent beam, which also has a third pair of horizontal bolt holes to the north (Fig 115). The third and fourth beams (NM3/4 and 4/5) have a series of rectangular horizontal through-sockets along their length. The southern ends of the fourth and fifth beams are supported by projecting timber corbels, similar to those in Old Mill, jointed with steel brackets and four bolts (Fig 114). The fifth beam (NM5/6) also has a series of horizontal bolt holes running through it along its length (Fig 114). There are three pairs between the south wall and the southern column, two single holes within rebates, a pair of holes, and another rebated single hole between the columns, and a single hole, a further bolt-hole pair, and two rebated single holes between the north column and the north wall (Figs 114 and 115). The sixth, eastern beam has an angled rebate in its soffit to the north of the southern column and two pairs of horizontal bolt holes between the northern column and the wall (Figs 114 and 115). This beam also has two cast-iron flitch plates, jointed with four bolts, between the two columns.

4.11.6 A 0.5m wide cast-iron upright shaft bracket spans between the first and second beams from the west at the north-east side of the block (Plate 62) with a 0.17m cast-iron beam to its south-west. This is offset from that on the floor below, suggesting an interrupted, rather than continuous, upright shaft, similar to that observed in the later Spring Garden Mill, Colne, Lancashire (OA North forthcoming), where similar brackets represent a late nineteenth-century upright power transmission system.

Plate 62: A cast-iron upright shaft bracket between the first and second beams

4.11.7 The timber plank ceiling is carried on east/west aligned narrow joists, placed on approximately 0.43m centres. In the northern part of the eastern bay (NMF7), 12 of the joists have a pair of bolt holes in their soffits (Fig 115). A further joist, placed eight from the south wall, has a similar bolt-hole pair, in line with those to the north. Four of the joists at the northern end of the western bay (NMF1) also have bolt holes in their soffits, but the pattern of their placement is less clear.

4.12 NEW MILL: SECOND FLOOR

4.12.1 The second floor is accessed from Old Mill by a fireproof door in its northern wall, from a landing on the external stair tower at its south-eastern corner, and from a covered raised walkway inserted from the Greg Room block to the south, along the external face of the stair tower and attached link block (Fig 111 and 121). This walkway is accessed by a 1.9m by 1.02m wide timber door, inserted into an earlier window aperture. The passageway beyond has a timber floor, corrugated sheet roof, and a timber plank wall to its western side, housing three single-light windows. At its southern end, a 1.02m wide timber door affords access to the upper floor of the Greg Rooms building. A modern timber staircase ascends to the 3rd floor of New Mill, immediately to the north of the walkway door (Fig 121).

4.12.2 The walls and windows are similar to the floor below, as is the arrangement of two rows of columns carrying the six, north/south aligned ceiling beams. The timber plank floor is also similar to that below, set 0.49m higher than that in the Old Mill to the north.

4.12.3 Two tie rods, each comprising two hooked wrought-iron bars (Plate 63), span east/west across the building at ceiling level, and are placed adjacent to joists in the centre of the room and towards its northern end (Fig 121). On the external face they have circular plates to the bolted ends (Figs 146 and 158). Similar rods survive in the same position at ground-floor level (Figs 106, 146, and 158).

Plate 63: The join of two hooked tie-rods which span east/west across the building

4.12.4 The remodelled hoist in the south wall only partially blocked the adjacent window, which now houses a 3-light timber-framed vertical window (Fig 121). The sheet-clad hoist tower is accessed through a 2.03m by 1.48m sliding timber door, with a steel I-section lintel above.

4.12.5 The timber ceiling beams retain evidence for the attachment of various bolts and brackets, similar to the other floors, with many wide rectangular bolt holes through the faces of the beams. The penultimate western beam (NMS2/3) has a narrow, edge-set reinforcing beam attached to its western side for the majority of its length (Fig 121). Both beams are pierced by several horizontal bolt holes: three single holes are positioned between the two columns and a further two singles holes, a pair of bolt holes, and a further single hole lie beyond the northern column. To the south of this final bolt, a square iron plate and bolt are attached to the western face of the beam. The third beam has a square rebate in its soffit at either end, with pairs of bolt holes in the soffits at the northern end of the third and fourth beams (NMS3/4 and NMS4/5), either side of a closed-web, T-section whale-backed beam across the central bay. It is 0.14m wide, with chamfered ends to a vertical mounting plate (Plate 64). A similar beam lies 2.1m to the south, with timber cross beams, arranged in two pairs 3.87m apart, and with 1.68m between the beams within each pair. The beams all have a pair of bolt holes in the soffit, placed either side of the centre line. The southern three examples are housed within small rebates, with the second beam from the south also having a rectangular cut-out between the bolt holes in the soffit. The northern beam retains bolts within the holes, and also has two smaller bolts to the west. These timber beams are placed in positions above those on the lower floors.

Plate 64: Between the timber beams is a cast iron, closed-web, T-section whale-backed beam across the central bay

4.12.6 The fourth beam from the west (NMS4/5) also has two rectangular scars on its eastern face adjacent to the iron beam (Fig 120) four further soffit rebates are present within the central part of this beam with a further cut out at its southern end. Both the fourth and fifth beams from the west have timber corbels and associated steel plates and bolts at the southern end, similar to other locations within the New and Old Mills, with the fifth beam also having an iron plate housing eight bolts, at the northern end (Fig 121). The eastern face of the beam also has a series of small bolt holes, which align with similar holes on the western face of the eastern beam, suggesting features spanning the penultimate bay.

4.12.7 At the southern side of the room, in the eastern bay (NMS7), the majority of joists have a pair of bolt holes in the soffit. Two of the joists in the adjacent bay also have identical pairs of bolt holes. This penultimate bay (NMS6) also houses seven cast-iron hangers for overhead rollers, four or which survive *in situ*.

4.13 NEW MILL: THIRD FLOOR

4.13.1 The third floor layout replicates that of the floors below, with a central 1.15m wide, sliding timber door with fireproof metal cladding into the Old Mill, and a 0.85m wide, timber batten door with a cut out for a cat flap at its base, affording access from the landing of the southern stair tower.

4.13.2 The window apertures are of slightly reduced height, measuring only 1.62m by 1.02m. Again, each has a stone sill and a timber lintel, with a chamfered, 0.14m high stone sill below the timber frame, which is similar to those on the floor below. That adjacent to the enlarged hoist tower in the southern wall is also of similar style to that on the second floor (Figs 125-6).

4.13.3 The columns and beams are similar to those below, with the beams having wide square through bolt holes. The first, fourth and sixth beams (NMT1/2, NMT4/5, NMT6/7) from the western side have timber corbels and associated steel bolts and plates at either end (Fig 126), similar to those elsewhere, whilst the third and fifth beams (NMT3/4, NMT5/6) have similar corbels at the southern end only (Fig 126). The western beam (NMT1/2) also has metal flitch plates bolted to either side at its southern end, strengthening the beam. The western beam has two centrally-placed horizontal bolt holes, aligning with a pair on the adjacent beam, and has four further pairs to the north of the northern column, two of which are aligned with those on the adjacent beam. The second beam from the west (NMT2/3) also has three bolt holes in its soffit, two forming a pair at the northern end, and a single hole within a square rebate to the north of the northern column. The third beam (NMT3/4) has two horizontal bolt holes through it at its northern end, with a pair of bolt holes in the soffit to the south, and adjacent to the north wall. The fourth beam NMT4/5 has a single horizontal bolt hole at its northern end.

Plate 65: A large cast-iron bearing plate for an upright shaft at the northern end of the bay

4.13.4 The central bay (NMT4) is spanned by five timber cross-beams (Fig 126), each similar to those on the floor below, with rebated bolt hole pairs in their soffits for shaft hangers. The southern two of these cross beams also have bolt hole pairs, placed 0.24m apart, and centred 0.3m from the eastern side of the bay, aligning with similar bolt hole pairs within the soffits of joists to both the north and south. Seven such pairs in the northern part of the bay have a similar bolt hole arrangement repeated 0.7m to the west. These may be associated with a substantial, 0.91m wide, cast iron bearing from an upright shaft (Plate 65), placed at the northern end of the bay, above a similar feature on the ground floor (*Section 4.10.4*). Offset from the centre of the room is a ceiling hatch up to the fourth floor. The framing for the stair to the east is carried on an angled timber rail, of similar scantling to the beams, and supported on the timber corbel below the ceiling beam of the fifth bay from the west (NMT5), which is cut short of the wall.

4.14 NEW MILL: FOURTH FLOOR

4.14.1 The upper floor of the New Mill comprises a single room with timber partitions within the eaves to weather-boarded access passages to the stair tower (Plate 51), the hoist tower, and to a short mezzanine floor above the southern bay of the Old Mill (Figs 129-30 and 167). The 0.85m wide stair tower batten door again has a cat hole at its base, and is placed at the end of a 2.95m long and 1.91m wide passage, erected against the southward-sloping principal rafter of the eastern truss (Fig 130). A second beam has been added for support on the eastern side of the passage, which incorporates several sections of modern plywood. On the western side of the passageway, adjacent to the stair tower wall, and placed 0.91m above floor level, a 0.91 x 0.61m timber hatch, within a timber frame (Plate 66), affords access onto the roof.

4.14.2 The doorway into the Old Mill is recessed 2.02m from the roof slope (Figs 130-131), within a 2.72m wide short passage, created between two trusses and cutting the lower two purlins. The trusses are supported by the addition of 196 x 72mm cast-iron braces attached with 28mm square-headed bolts (Plate 66). The doorway itself is recessed a further 0.4m and contains an iron fire door with three iron latches, operated by a single handle, and appears original to the construction of the New Mill.

4.14.3 The doors to the hoist tower and privy, which extends in brick above the external walls, are recessed within a 2.75m long passage, which has a small dormer roof of 1.59m width butting the external tower (Fig 130). The doorways are separated by a 0.29m plastered brick pier, which appears original, as do the two doorways, despite the remodelling of the hoist tower. The privy tower has a narrow, 0.68m wide, batten door with a 0.16m brick step below it. The hoist tower retains a wider 0.91m batten door (Plate 62).

Plate 66: A timber hatch in the passageway of the upper floor of the New Mill, which provides access to the roof

Plate 67: Entrances to privy and hoist towers from the fourth floor

4.14.4 Only the brick gables extend up to the fourth floor, which effectively comprises the roof space of the mill, and both are internally plastered, as are the undersides of the roof, sealing the rafters. Both walls have a window to each of three bays, matching those of the three central bays below (Plate 51). They have stone sills with a further 0.1m high chamfered stone sill below the timber window frames. The internal lintels are obscured by plaster.

4.14.5 The large ceiling height is created by the use of a mansard roof, which effectively creates a full-height floor and a loft within the roof (Plate 68). It comprises six trusses, set perpendicular to those within the Old Mill, each having a steeply-angled, 0.10 x 0.06m principal rafter from the ceiling beam below to the soffit of a tie beam, with a shallower principal rafter above forming the blade of a king post truss (Plate 69). It is common for the lower part of a mansard to include queen posts, which carry the lower purlin and the straining beam, and have the lower principal tenoned into a jowled head to provide a very stable joint (Brunskill 1994). However, those within the New Mill do not have queen posts (Plate 68), creating shear stress at the tie beam joint, with some of the weight being transferred along the lower of two side purlins, which are clasped below the principals with iron fish plates.

4.14.6 This may explain the addition of two rows of columns beneath the western four trusses, above those on the floors below (Plate 68). These, however, were of similar style to the late columns of the first floor of the Old Mill, comprising slender columns of 36mm diameter below a separate 124mm square capital with two 11mm² bolts attaching the column to the soffit of the beam. Their feet are obscured beneath the floor.

Plate 68: Interior of the fourth floor of the New Mill

Plate 69: King post truss of the New Mill roof

4.14.7 The tie beams of the trusses carry king posts, which taper slightly from 240mm wide at their base to 170mm wide at the roof apex, where the joint between the king post and the principal rafters is obscured by the plastered ceilings (Plate 68). The king posts have jowled feet, carrying angled braces, placed above the upper purlins (Plate 69), and are bolted to the tie beam with 40mm square-headed bolts below 62mm square cast-iron plates.

4.14.8 The roof is of Welsh slate, and is covered internally by plasterboard (Plate 68). Seven, almost vertical skylights, measuring 1m by 0.9m were placed within the roof of the steeper, lower pitch of the roof, four on the south pitch, and three to the north (Plate 68) (Figs 131-132). A further small skylight is placed at the apex of the north pitch, in the second bay (NMFO2; Fig 132); it illuminates the upper loft, which houses the headgear for the hoist tower to the south (Plate 70). The loft is accessed through a 0.68m by 0.52m hatch between the joists of the central bay, below the ridge.

4.14.9 The hoist mechanism, which is placed in the second through fourth bays (NMFO2-4; Fig 130), comprises two main belt drums, one above the floor hatch in the central bay (Plate 70), and a parallel drum, two bays to the west (NMFO2). Both are framed upon a pair of timber rails, housing the axles for short shafts, with the drums being connected by a leather belt (Plate 71). The southern end of the western shaft has a gearing wheel, which drives a much larger toothed wheel at the northern end of a shaft which runs south into the top of the hoist tower (Plate 70), within a raised 0.69m wide dormer. At the eastern end of the loft, a 1.08 x 0.78m timber pad forms the back plate of the mounting for an external flagpole on the eastern facade (Plate 72).

Plate 70: Headgear for the hoist tower in the fourth-floor loft

Plate 71: Belt drums and belt in the in the fourth-floor loft

Plate 72: Back plate mounting for an external flagpole on the eastern facade

4.15 THE GREG ROOMS: GROUND FLOOR

4.15.1 ***Introduction:*** the structure presently referred to as the Greg Rooms comprises three phases of construction; a three-storey, six-bay main block, aligned north-south, and measuring 17.3m by 8.05m with a hipped Welsh slate roof (Plate 73; Fig 143-5, 147-8, 161-4 and 166); a narrow, single-bay link-block, of three shorter stories, attaching the structure to the offset New Mill, and measuring 3.78m by 3.2m (Figs 103-5; Plate 74); and a rectangular 2x2 bay, two storey extension at its south-western end, measuring 5.57m by 5.02m (Plate 75). All are of three-stretcher English Garden Wall bond construction, bonded with a pale lime-based mortar.

Plate 73: East elevation of the Greg Rooms

4.15.2 ***Ground Floor:*** the ground floor of all three phases of the structure has been heavily remodelled. The link block comprises a single room, with doorways to the north into the New Mill stair tower, and affording external access from both the east and west sides, that on the eastern side having a flight of sandstone steps down from the higher-level road to the east of the mill, and housing a timber plank door with a flat sandstone lintel (Plate 74) (Fig 105). It is flanked by a 25-light timber window, with projecting sandstone sill, the lintel of which is obscured behind a continuous lead flashing, forming a shallow canopy above both window and door (Figs 104-5; Plate 74; Fig 145).

Plate 74: External eastern elevation of the Link Block

4.15.3 The ground floor of the main structure has been remodelled extensively into a suite of toilets and washrooms for visitors to the complex. Suspended ceilings, partition walls, ceramic tiles to floors and walls, and sanitary furniture mask any detail within the structure. However, the windows survive in the east wall, comprising 16-light timber windows with projecting sandstone sills, and camber arch brick lintels, matching those of the first floor, and are similar in style to those within the main mill to the north, but are slightly narrower (1.03m), and significantly shorter, at only 1.18m in height (Plate 73). Similar window apertures in the northern three bays of the west wall (GRG1-3) were offset 0.91m to the north of the first floor windows above, with the northern two examples having replaced window frames (Fig 164; Plate 76). A similar window in the south bay (GRG6) was placed below the taller window at first-floor level (Fig 164). The ground-floor windows of the west wall were possibly offset to accommodate a 2.9m wide double doorway, with shallow camber arched brick lintel (Plate 74) located at the northern end of the third bay (GRG3) (Figs 105 and 164). A short stub of wall extending south to first-floor height, at the end of the west wall is of five-stretcher English garden wall bond construction, and butts the Greg Room block; it supports a pedestrian walkway. It has a flat sandstone lintel at its northern end, partially keyed into the elevation to the north, forming the lintel of a blocked doorway that was placed against the earlier structure (Plate 77).

4.15.4 The ground floor of the southern office extension to the Greg Rooms comprises a workshop. This has a step down from the eastern courtyard through a timber plank door at the southern end of the west wall, below a brick camber arch. The south elevation has similar windows to those of the main Greg Room structure to each of the two transverse bays (Figs 104 and 147; Plate 75), whilst the east wall is cut into the hill slope. Internally it is heavily painted, and has a single transverse ceiling beam below a plastered ceiling, and houses staff toilet cubicles, sinks and washing machines.

Plate 75: Two-storey extension at the southern end of the Greg Rooms

Plate 76: Ground-floor windows of the western elevation of the Greg Rooms

Plate 77: A short stub of wall extending south from the Greg Rooms supporting a pedestrian bridge

4.16 THE GREG ROOMS: FIRST FLOOR

4.16.1 The link block between the Greg Rooms and the New Mill is raised 0.66m above the floor of the Greg Rooms, forming a continuation of the floor level within the New Mill stair tower. Access for the link block was inserted into the southern wall of the stair tower, through a 1.98m by 0.67m timber batten door, affording internal access between the New Mill and the Greg Rooms (Fig 113). The south wall of the link block retains a 0.61m wide, open doorway, affording access to a modern timber stair leading down into the Greg Room block (Fig 113).

4.16.2 The link block has no fenestration at this level, and has two, 0.11m wide, transverse, rectangular-section timber beams, placed adjacent to the longer elevations, carrying 0.08m wide timber rafters on 0.42m centres. The ceiling above is plastered, whilst the floor is of timber planks.

4.16.3 The Greg Rooms comprise six bays of 3.24m width, with a wider bay at its southern end (GRF6), and is divided into four chambers at first-floor level, with a large office in the extension to the south. The northern of the rooms is the largest, measuring 10.13m by 7.33m, comprising the northern four bays (GRF1-4) of the structure. Access is from both the link block, and also from an external, covered raised walkway from the New Mill, placed against the wall of the link block (Plate 78). As with the doorway to the east, from the link block, this doorway has an internal modern stair between the differing floor levels of the New Mill and the Greg Rooms. A further 2.25m by 1.12m panelled timber door, placed in the third bay (GRF3) from the link block in the south-east elevation, affords access from the main entrance road, via a flagstone bridge, flanked with iron railings, over the gap between the mill and the road (Plate 73). Externally it has a similar head to the adjacent windows, and the aperture is of the same height, suggesting that it possibly represents a remodelled window.

4.16.4 A blocked archway survives within the north wall, to the west of the link block, placed 0.8m from the southern end of the wall (Fig 113). It is set lower than the other doors in this wall, and represents the original access to this level of the structure, presumably from an external, probably timber, stair. It was blocked upon the addition of the link block, which afforded more efficient access between the Greg Rooms and the main mill structure.

4.16.5 In the eastern elevation, each bay (other than that housing the doorway) has a centrally-placed vertical window, similar in style to those within the main mill to the north, but slightly narrower (1.03m), and significantly shorter, at only 1.18m in height (Plate 71). They house 16-light timber window frames, the top row of which has a tilt opening, placed above an internal stone sill. Similar windows are placed in the north-western wall, but these were placed at the bay divisions, below the rectangular ceiling beams at each bay division, numbering only three in total.

Plate 78: The external covered raised walkway linking the New Mill and the Greg Rooms

4.16.6 The 0.18m wide ceiling beams are carried on centrally-placed cast-iron columns of 0.12m diameter. These have flat head-plates, measuring 485mm x 200mm, and 38mm thick, with concavely filleted corners, and are attached to the beam with a single square bolt at either side. The column is chamfered and ribbed to the head plate above two simple astragals, set 230mm and 874mm below (Plate 79). The column has a 52mm high foot, set on a 470 x 250mm base plate with rounded ends.

4.16.7 Two cast-iron, open-web, whale-backed T-section beams (Plate 79) span from the south wall to the adjacent ceiling beam (GRF3/4). They are housed in channel-section brackets bolted to the ceiling beam, and also to an additional timber housed within the south-west wall. They are placed at one-third intervals across the structure, and carry an additional timber beam, forming an H-shaped frame above the central south-west end of the room. A cast-iron bracket attached to the south-western side of the ceiling beam was associated with a further element of this framing. A, 0.61m wide, bull-nosed pier projects 0.34m from the southern wall, within the area of framing to the north, and has a tie rod plate in its face (Plate 79). It is probable that this is also associated with the framing structure.

Plate 79: Two cast-iron, open-web, whale-backed T-section beams span from the south-west wall to the adjacent ceiling beam

4.16.8 Each of the three ceiling beams also has a pair of bolt holes in the soffit, forming an alignment adjacent to the western wall. The central beam has a further square of four bolt holes, placed immediately to the south-east, for an associated bracket. This is strongly suggestive that a line shaft was placed within this room, with the four bolts possibly housing a small electric motor to power the shaft.

4.16.9 The plastered ceiling is carried on longitudinal rafters, placed on 0.42m centres, with several retaining bolt holes in the western part of the room. Three pairs of aligned holes are visible at the north-west end of the room in the soffits of the first and third rafters from the north. Two pairs are aligned in the central area of the room on the fifth and seventh rafters, with another pair also aligned, but set wider apart, on the third rafter. To the south-west, another two pairs of holes are aligned on the fifth and seventh rafters. The six pairs in the northern bay (GRF1) possibly carried a drum and end bearing, placed at the end of the line shaft, whilst those in the third bay (GRF3) appear to relate to the translation of power to a wide housing defined by the four bolt pairs (Fig 113). This probably carried a drum or wheel on a short additional, perpendicular shaft.

4.16.10 Two 0.86m wide timber batten doors in the south wall afford access into two rooms in the adjacent bay (GRF5). The western of these was the Cotton Testing Room, and measures 3.48m wide, with an additional doorway in its eastern wall into a slightly wider Waiting Room. The west wall houses a central window, taller than those to the north, and has a 16-light vertical sash, which represents one of a few such windows within the complex. In the north-east corner of the room is a plastered brick pier, with a tie-rod plate in its face. It does not extend to roof level and is likely to be associated with the projecting wall to the north-east. Although these piers and their tie rods do not align, they almost certainly provided support for the mechanism attached originally to the wood and cast-iron beam frame above.

4.16.11 The adjacent Waiting Room is similarly plastered, and measures 3.8m wide. It has timber panelled doorways in each wall, with internal openings to the north into the main room, to the west into the cotton testing room, and to the south, affording access to the Counting House. A doorway at the northern end of the east elevation affords external access from the road, again via a flagstone bridge, flanked with iron railings (Plate 73). This doorway differs from that to the north, being placed within a lower aperture (Plate 72), suggesting that it represented the sole original access from the road to the east, with controlled access to the internal rooms then being provided from the waiting room vestibule. Its placement, adjacent to the cross-wall, is also consistent with it forming an original aperture, and it is flanked on its southern side by an eight-light, 0.52m wide timber-framed window (Fig 112; Plate 73).

4.16.12 At the eastern end of the south internal wall is a 0.27 x 0.24m timber-framed hatch (Plate 80). This allowed employees to be paid from the adjacent desk within the Counting House, without the need for them to enter the room itself. The doorway from the Waiting Room to the Counting House presently houses a latched gate, but this presumably replaced an earlier substantive door. All three chambers at this end of the structure have plastered ceilings, concealing beams and rafters. The timber floorboards are covered with linoleum.

4.16.13 The Counting House forms the southern bay (GRF6) of the original structure, which is slightly wider than those to the north, at 3.35m. The doorway from the Waiting Room is flanked by a timber-panelled partition, for a length of 0.91m, with a similar canopy above. The west wall houses a central sash window, identical to that in the bay to the north (GRF5) (Plate 81), whilst the south wall retains a 16-light removable timber window, similar to those in the large room at the northern end of the structure. The window is offset to the east of an integral wall safe, which appears to occupy an original aperture (Plate 81), although it is not clear whether the safe itself is original. To the east of the window is a 1.46m wide fireplace, with projecting leaded surround and hearth (Fig 112; Plate 82). A doorway beyond the fireplace, afforded access into the large office that was set within a later extension. It almost certainly represents a remodelled window, and one that was presumably similar in style to that at the western end of the elevation. The east wall houses a large triple window of 2m width, comprising a 20-light central frame, flanked by 10-light panels beyond simple timber mullions (Plate 73).

Plate 80: A timber-framed hatch which allowed employees to be paid from the adjacent desk within the Counting House

Plate 81: Interior of the Counting House

Plate 82: Fireplace within the Counting House

4.16.14 The extension to the south-east of the Greg Rooms houses a large office at first-floor level. This has an internal area of 4.8m by 4.23m and is solely accessed from the Counting House to the north-east. Its east external wall projects beyond the elevation of the Greg Rooms (Plate 74) and is thicker than the other walls of the extension, being of two, rather than single brick, thickness (0.46m wide compared to 0.26m thickness). The structure has a hipped roof behind a moulded timber cornice and parapet wall, unlike the simpler hipped roof of the earlier structure (Plate 75).

4.16.15 The eastern and southern walls each retain two 16-light vertical sash windows, similar to those of the Counting House and Cotton Testing Room (Plate 83), but with shallower, single brick camber-arched lintels externally (Plate 75). The north-western wall retains a substantial 1.9m wide projecting chimney breast, with a central 1.53m wide fireplace. The floor of 130mm wide timber planks is presently partially carpeted, whilst the ceiling is plastered, obscuring the rafters (Plate 83). A substantial 0.3m wide timber beam spans the room along the north-east wall, forming the wall plate for the hipped roof above. Timber beading follows the line of the valley beams to a rectangular false ceiling of 1.5m by 1.3m above the centre of the room, itself outlined with similar timber beading. The date of the furniture and fittings within both the office and the Counting House is unclear.

Plate 83: The interior of the Greg Rooms Office

4.17 THE GREG ROOMS: SECOND FLOOR

4.17.1 The upper floor of the Greg Rooms comprised a single large room measuring 17.53 x 8.22m. Its principal access was through a 1.02m wide doorway from covered raised walkway along the western side of the link block, from the New Mill, and latterly through a 1.04m wide, central door in the southern wall, which presumably originally housed a hoist, but now affords access from a raised timber walkway over the road to the stable block (Plate 75), and also continuing across the courtyard to the upper floor of the three-storey weaving shed (Figs 119-120; Plate 84). A further door in the north wall affords access up a 0.2m step, into a small 4.3 x 2.87m storage room in the upper floor of the link block, and which has a timber-framed glazing band in its eastern wall, below a rebuild wall head (Plate 74). The link block also has a single east/west aligned ceiling beam.

4.17.2 The main room has windows to each bay, similar to those of the floors below and are 1.07m in height, shorter than those in either the Old or New Mills. That of the northern bay (GRS1) of the west wall was enlarged to form a wide double doorway onto an inserted raised walkway between this room and the upper floor of the three-storey weaving shed on the opposite side of the courtyard (Plate 74), and also attached to the hoist tower of the New Mill (Plate 49). The southern elevation widens to either side of the doorway (Fig 119), which was inserted into the chimney breast of the Counting House fireplace (*Section 4.6.13*), with a plain rectangular 0.91 x 0.45m brick chimney stack projecting through the hipped roof above (Plate 75).

Plate 84: Raised timber walkway leading to the Greg Rooms

4.17.3 The Welsh slate roof is internally plaster sealed above the four exposed trusses (Plate 81), with angled valley beams to each corner from the outer trusses. The roof also houses three 1.14 x 0.82m skylights, each with an associated small pulley wheel at their base, suggesting that they may originally have formed roof hatches.

Plate 85: Trusses with the angled beams of the Greg Rooms roof

4.17.4 The trusses are king post trusses, the posts being bolted to the tie beams and have jowled feet for angled braces to the principal rafters immediately below the upper of two trenched purlins; there are further slender braces from the tie beam below the lower purlins (Figs 119-120 and 166). Only the eastern brace survives, although the tenon for the original western brace is visible on each pitch (Plate 85). The head of each king post is also jowled to accept the principal rafters, and although obscured by the ceiling, it is likely that it also clasped a slender ridge board (Plate 85). None of the tie beams have joist sockets for a loft, and whilst some have rebates in their faces, relating to various attachments, there is no substantive evidence for the presence of a power line shaft at any time.

4.18 ENGINE HOUSE

4.18.1 ***Introduction:*** the original engine house was replaced in the 1830s with a new structure, erected at the northern end of Old Mill (*Section 3.5.12*). It spanned the full width of the Old Mill, and was then extended in 1843 to the west up to the River Bollin, to allow for the installation of a new boiler in 1843. The engine house was also extended to the east in 1853 for a replacement of the original boiler, with this structure having narrower brick walls above a battered ground floor wall of roughly-dressed sandstone blocks (Figs 2, 101, 139-140, 142 and 173). While the 1853 Cornish boiler was able to provide sufficient power for the McNaughted steam engine, for which it was intended, it was not sufficient to power the two steam engines that were in place from 1871. This led to the installation in 1871 of a new boiler, that was located within a new boiler house below the road, and to the south-east of the earlier boiler. Each element or extension reflects a distinct phase of development, and the description below examines each in turn showing how the power system was modified, starting with the earliest, the 1836 Engine House.

4.18.2 ***1836 Engine House:*** the 1836 engine house spanned the full width of the Old Mill, measuring 9.25m by 4.5m on a broadly east-west alignment. The narrow engine house was of two-storey height butting onto the northern end of the Old Mill, with apertures at lower ground-floor level, within the north gable of the Old Mill, being remodelled from windows to form a doorway between the new structures at the western side, and to form the housing for the bearing of the primary motion shaft that extended out from the new engine (Plate 16; Figs 101, 139-140). The scar of the original west wall of the boiler house survives in the north wall at ground-floor level, with the upper part of the wall also extant above the lower roof of the extended boiler house.

4.18.3 The structure was erected in four-stretcher English Garden Wall bond, bonded in a pale lime mortar. Internal render survives on its northern wall, with elements of whitewash adhering to its south wall. The hipped roof is continuous into the extended boiler house, probably dating from when the boiler house was constructed (1853), and is carried on timber king post trusses, with iron stirrups to the principal joints (Plate 86), with cleats to three butt-ended purlins on each pitch, the upper ones forming the ridge. The western valley beams are carried on an extant element of the original west wall, which rises above the later extension to the south.

Plate 86: King post trusses, with iron stirrups, forming the hipped roof of the Engine House

4.18.4 *Upper Floor of the 1836 Engine House:* the upper floor of the engine house has windows to each bay, with the two windows in the gable of the Old Mill also being retained (Plate 87; Fig 109), but with timber shutters on the internal face of the Old Mill. Although in a later extension, there are nine-light sash windows in the two eastern bays of the south wall (EHG9-10) of the extended boiler house (Plate 87), that have similar surrounds as those in the 1836 engine house. There was also a further sash window in the west bay of the north wall (EHG1). The engine house has an external doorway in its northern wall, with a round-headed brick lintel, and a short flight of three steps to a passage along the northern side of the mill (Plate 89).

4.18.5 *Lower Floor of the Engine House:* the original engine was placed on a dressed sandstone block bed, with a flywheel pit on its southern side (Fig 101). A similar engine, presently installed in this position, appears slightly smaller than that originally present, as the original fixing boltholes within the bed are set wider, and further apart (Plate 90).

Plate 87: Interior of the Engine House Upper Floor

Plate 88: External northern elevation of the Engine House

Plate 89: External door in the northern wall of the Engine House

Plate 90: Redundant boltholes in the floor of the Engine House recording the location of the original engine

4.18.6 ***1843 Western Boiler House:*** the engine house was extended to the River Bollin frontage in 1843, and comprised a lower, flat-roofed brick structure, in five-stretcher English Garden Wall Bond. It shares its alignment with the earlier boiler house to the east and measures 10.83m by 4.5m, over two storeys. The upper level is presently part of the archives store and can only be accessed from the 1843 Preparation Block (Fig 109). A narrower window in the western wall afforded light to the working platform that was above the boiler (now the archive room); its narrower form matches those of the mixing room which formed the upper storey of the 1843 preparation block and which was apparently of the same date (Plate 24), but has a clear butt joint to the boiler house on its external wall face (Plate 92). The north wall of the upper floor of the boiler house has a small window in the eastern bay (EHG3), with a central door, and a roll-moulded sandstone threshold forming the access to the top of the boiler (Plate 91).

4.18.7 *Lower level:* in the lower level the northern wall has windows to the western three bays (EHLG1-3) in the lower ground-floor level of the north wall (Fig 101), similar to those of the main mill, but housing four-light timber frames (Fig 110; Plate 91). The western wall housed a larger vertical window at the lower level (Plate 92; Fig 141) which was substantially broader than the window for the upper level. It may originally have represented a doorway, with an external stair affording access to a charging platform; the boiler was almost certainly located on that orientation to place the exhaust flue closer to the earlier chimney.

4.18.8 Internally the 1843 the ceiling of lower boiler house level has transverse brick arched vaulting, carried on inverted T-section cast-iron lintel and braced by pairs of square-section wrought-iron tie rods (Plate 93). The brickwork of the vaulting is heavily rendered.

Plate 91: The northern external view of the Engine House

Plate 92: The western elevation and the large lower level vertical window

Plate 93: The cast-iron T-section beams braced by tie rods

4.18.9 The boiler was removed in 1871, and replaced by a supplementary engine, with a sandstone block axle mounting being inserted into the dividing wall, with an internal cast-iron bearing box (Plate 94). This forms the drive shaft for the present museum engine, but a 0.71m² cast-iron bearing box placed slightly higher in the wall to the east (Fig 110; Plate 95) suggests that the 1871 engine had a pinion wheel forming the primary motion shaft, presumably increasing the speed of the shaft from the flywheel before powering machines in the adjacent Blowing Room.

Plate 94: The bearing box partly obscured by present museum engine

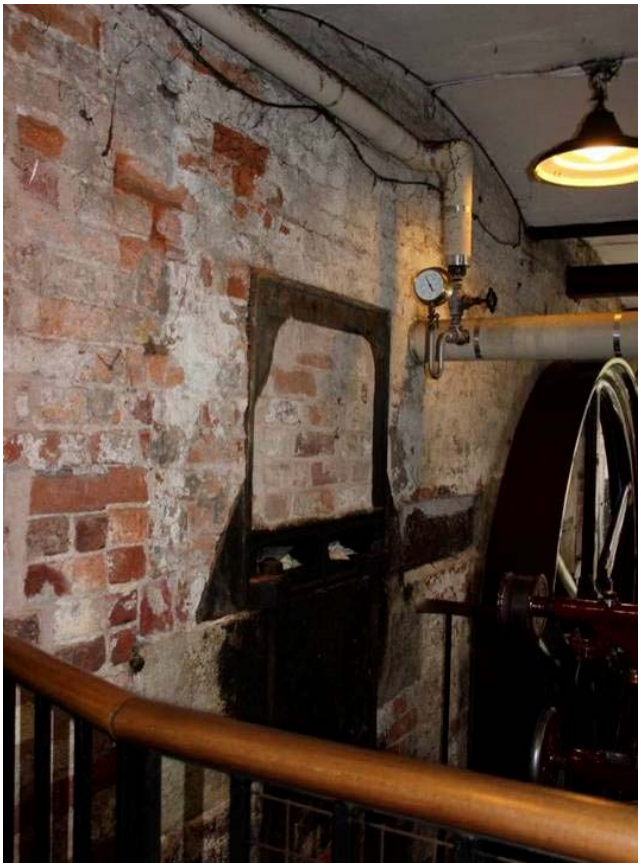


Plate 95: A large cast-iron bearing box possibly for the primary drive shaft

4.18.10 ***1853 Eastern Boiler House:*** prior to the installation of the new engine in 1871, an additional boiler was installed in a two-storey eastern extension of the engine house (*Section 3.7.6*). This extension measured 7.9m by 4.5m upon an east/west alignment with the structure rising to ground-floor level above the boiler placed at lower ground floor level adjacent to the engine. The additional boiler comprised a second-hand Cornish boiler (*Section 3.6.13*; Fig 43), with a plan of the following year showing the '*New Boiler House*' (Fig 44).

4.18.11 *Upper Ground Floor:* the roof structure and upper level were for the most contiguous with the earlier 1836 engine house (Fig 109). It has nine-light sash windows, within similar surrounds as those of the engine house, in the two eastern bays of the south wall of the boiler house (EHG 5 and 6) (Plate 87), with a further sash window in the east bay (EHG6) of the north wall.

4.18.12 *Lower Ground Floor:* the majority of both side walls of the lower level of this extension were faced with revetted, roughly-dressed sandstone blocks in both elevations (Fig 101; Plate 96), below four-stretcher English Garden Wall bond brickwork. This block-work could be interpreted as a form of blast protection, should the boiler explode, but this is an unprecedented technique. The wall also has a circular, brick-blocked aperture at its head on the southern side (Plate 97), reminiscent of an axle mount, but there is no similar aperture extant on the opposite wall. Joist sockets adjacent, and in the opposite face, represent supports for later flooring, probably inserted at the time the aperture was blocked.

Plate 96: The eastern section of the Engine House which accommodated a Cornish boiler

Plate 97: Substantial block work with a blocked semi-circular aperture

4.18.13 ***1871 Eastern Boiler House Extension:*** the 1853 Cornish boiler was installed to power the McNaughted steam engine, but did not have sufficient power for the two steam engines in place from 1871, leading to the installation of a new boiler. The new boiler was housed in a cell below the road, to the south-east of the existing boiler, measuring 14.6m by 5.7m and was aligned east/west.

4.18.14 *Upper Level:* this boiler was accessed from road deck level, through what was a standard mid-nineteenth century boiler house, comprising a single-storey narrow gabled structure, in five Stretcher English Garden Wall bond, with coped sandstone kneelers to the eaves and a pitched slate roof (Fig 117; Plate 98). It housed a narrower than typical central-arched doorway (Plate 98), which afforded access down to the charging platform at the eastern end of the boiler, and presumably also to the top of the boiler.

4.18.15 *Lower Boiler Room and Chimney* (Figs 109-110)*:* the Mill Memoranda describe it as a 28ft boiler with two flues (*Section 3.7.6*), and, although it was removed subsequently and the structure remodelled for the insertion of a gas boiler and heating system, the rear of the flues survive, including poorly preserved flue dampers, their layout demonstrating the boiler to be of Cornish, rather than Lancashire type. The refractory brick-lined flues (Plate 99) led to a newly erected octagonal brick chimney (Figs 102; Plate 100), which was placed in the re-entrant between the stair tower and the Old Mill, and comprised a tapering brick stack below a sandstone string band and octagonal sandstone cap. The chimney has a brick-blocked arched access aperture at first-floor level on its eastern side (Plate 101), and has now been restored and repointed.

Plate 98: Western elevation of the 1871 Boiler House (to right) and 1880 Boiler House (to left)

Plate 99: A refractory-lined flue leading to the chimney

Plates 100 and 101: The octagonal brick chimney located in the re-entrant between stair tower and Old Mill. It has a brick-blocked arched access aperture at first-floor level on its eastern side (right)

4.18.16 ***1880s extensions to the eastern boiler house:*** even after the 1871 boiler house was constructed the 1853 boiler was retained, and a short flue (Plate 102) to the new chimney was inserted through the south wall of the boiler house to the chimney. The boiler was replaced in 1880, when a larger Cornish boiler was installed, extending the engine house beneath the road. This was housed within an east-west aligned, two-storey structure, measuring approximately 7.8 x 4.2m, placed parallel to, and on the northern side of the earlier Cornish boiler (Fig 102). The boiler was moved further to the east in 1889, within an extension of *c* 5.0m, for the addition of an economiser between the boiler and the chimney, which, although it involved a significant undertaking to move the boiler, was worthwhile for the fuel savings that it could produce by using the exhaust from the boilers to pre-heat the water entering them. This was placed in the position of the 1853 boiler, and was lined with refractory brick, with a flue inserted to the rear of the repositioned boiler, connecting the economiser to the 1871 boiler to the south. The flue from the 1853 boiler to the 1871 chimney was also remodelled by the addition of a second flue, 1.45m high and 0.75m wide, and of refractory brick construction. The earlier flue to the north was retained, to act as a bypass flue to allow the power plant to operate independently of the economiser, should the need arise during maintenance. Both flues were fed from a wider aperture in the south wall, which retains a sagging, inverted T-section, cast-iron lintel (Plate 102).

4.18.17 Evidence for the original position of the 1880 boiler survives, and mainly comprises its barrel-vaulted brick chamber beneath the road (Plate 103). A butt joint to the east of the vaulted tunnel suggests that the wall to the east dates from the structures extension to accommodate the economiser. The north wall also retains sloping cut bedrock at its eastern end, possibly forming a ramp to a charging platform for the original position of the 1880 boiler. This was increased in height in brick within a further brick building at road level (Plate 104), and had more of the appearance of a door through a walled garden, but still retaining a sandstone impost from the earlier boiler house to the south that was dated 1880 (Plate 104). The low structure to the rear was roofed, but this collapsed in the mid-twentieth century and was more recently replaced with a single-pitch glazed roof.

4.18.18 The east wall of the extended boiler house was cut entirely through the bedrock, and had an approximately 1.2m wide, 0.6m deep, vertical coal chute at its northern end, shuttered with vertical timber beams (Plate 105). This fed a charging platform at lower ground-floor level, from road level, at approximately first-floor height, and the bottom of the east wall was undercut by approximately 0.9m and to a similar height, in a slightly spherical shape, to allow for the coal to be stored at the rear of the charging platform (Plate 105), and so maintaining a good working area in front of the boiler.

Plate 102: The flues were fed by a wide aperture supported by a T shaped cast-iron lintel

Plate 103: Site of the 1880 boiler in a barrel-vaulted brick chamber beneath the road

Plate 104: A sandstone impost from the earlier boiler house (1871) links to the later boiler house and is dated to 1880

Plate 105: The east wall of the extended boiler house, cut through bedrock, had a vertical coal chute shuttered with timbers

4.19 WESTERN RANGE: 1843 PREPARATION BLOCK

4.19.1 ***External Fabric:*** this two-storey, eight bay structure, measures 23.15 x 9.20m on a north-south alignment, and replaced an earlier, narrower scutching room on the eastern bank of the River Bollin (Figs 135, 136, 138, 153 and 167). It was constructed of hand-made, mould-thrown brick, in five-stretcher English Garden Wall bond, above a dressed red sandstone plinth on its western side, which canalises the river to ground-floor level (Plates 24 and 106). This also housed the wide arch of the tailrace of the northern internal wheel pit, placed below the northern bay (PBLG1) (Fig 101) of the preparation block, which has a much narrower and shorter brick built and faced culvert housing than the present tailrace.

Plate 106: Western elevation of the Preparation Block

4.19.2 Above the sandstone plinth, the western façade has 45-light vertical timber windows to each bay of both floors, below flush sandstone flat lintels, with angled ends, complimenting the camber arched lintels of the Old Mill to the east. The windows of the lower floor had wider transoms above the fifth row of lights, with the panel below being removable, whilst those of the upper bays had thicker transoms above the fourth and seventh rows (Fig 138; Plate 106), with the upper section forming a centrally mounted tilt opening. A wrought-iron balcony projects from the first floor, spanning the fourth and fifth windows, and carried on a cast-iron beam frame (Plate 106). The intended purpose of this balcony remains uncertain, although it is unlikely to be an original feature. The structure has a flat roof, concealed behind a rebuilt parapet wall.

4.19.3 ***Lower Ground Floor:*** internally, the ground floor formed a blowing room (Figs 100-101), but presently comprises an open-plan engineering workshop (Plate 107), measuring 24 x 11m, retaining a partially flagged stone floor, and situated *c* 0.72m lower than the flagged yard to the south and east (Fig 108). This comprises an area of approximately 7 x 3.5m in the north-western part of the room, where the exposed flagstones are 70mm below the surface of the adjacent concrete floor, suggesting that it may continue beneath. The majority of the floor is of concrete, capping the tunnels beneath the blowers with a concrete ramp leading up to a 2.1m wide external door in the south wall, affording access from the northern end of the courtyard. This doorway represents a widening of an earlier aperture, with the south-eastern corner of the structure having been removed, to form a wider southern bay (PBLG9), which blocks the passageway between Old Mill and the western range of buildings. A 0.82m wide timber door within this inserted partition to the north of the widened bay, affords access to the enclosed northern part of the yard, onto which all, but the northern two windows of the east wall, have been brick-blocked.

Plate 107: Interior of the ground floor of the Preparation Block, now a workshop

4.19.4 At the northern end of the room, a 0.72m high flight of metal steps, leads to a 1.03m wide, modern timber door giving access to the present engine house (Plate 107). At the southern extant end of the east wall, a 2.95m high and 0.68m wide, round-headed archway forms the narrow opening to a spiral sandstone stair, enclosed within a tower projecting beyond the east wall, and with a central sandstone newel (Fig 100; Plate 108). A similar aperture, also with bull-nosed reveals and placed 0.71m to the north, retains original timber framing for two cupboards placed beneath the spiral stair, each with a timber panelled door (Plate 109). The staircase was not accessible due to materials being stored all the way up, and it is clinker block blocked at first-floor level.

4.19.5 To the north, the wall is internally plastered, with the window apertures of the adjacent four bays blocked to within 0.12m of the wall face (Plate 110). The bay to the north (PBLG3) retains a 1.62m high, 1.19m wide window, with a flat stone sill below a 0.18m high brick plinth to a 25-light timber framed window, which is inwardly opening on a hinge on its northern side. A further window in the penultimate bay (PBLG2) is larger, measuring 2.02 x 1.2m, with a plastered brick sill and a timber lintel. It houses a 35-light timber window, with a removable frame, of 25-lights comprising all but the upper two rows, which contains a ventilation fan at its left side. The west wall has eight windows, each round-headed internally, and measuring 2.45 x 1.24m, with a stone sill, and housing a 25-light removable frame below a fixed upper 20-light window.


Plates 108 and 109: A rounded archway forms the opening to a spiral stair (left). A comparable aperture retains the framing for two cupboards beneath the stair

4.19.6 The ceiling of the ground floor is brick vaulted (Plate 112), comprising seven full bays of 2.44m width, with a narrower 0.8m wide vault at the northern end, butting the thick engine house wall to the north, and a slightly reduced 2.31m wide vault adjacent to the south wall (Figs 108-109). The vaults are carried on inverted T-section cast-iron beams, housed on sandstone pads in the external walls, these being visible in the western façade of the structure (Plate 110). Each beam comprises two members, which clasp the head of a 0.13m diameter hollow cylindrical column, above a semi-circular head plate (Plate 111). These columns are offset slightly to the west of the centre, and have 20mm wider feet, only visible above the flagstone floor beneath the three northern columns.

Plate 110: The interior of the ground-floor workshop showing the brick-vaulted ceiling

Plate 111: Columns and cross-beams of the ground floor

4.19.7 The plastered vaults are not typical barrel-vaults, having steep sides to shallow arches, suggesting the use of large-section iron beams. In both narrower vaults, six cylindrical wrought iron tie rods span the vaulting (Plate 112), bracing the structure, and are set high within the vault, and presumably socketed into the rib of the beam. Only a single tie beam in the wider bays was observed, in an area of collapsed render above the brick vaulting, with the tie rod encased almost entirely within the brickwork of the shallow vault (Plate 113).

Plate 112: Six cylindrical wrought-iron tie rods span the narrower vaults

Plate 113: In the wider bays the tie rod was encased within the brickwork of the shallow vault

4.19.8 A large blocked cast-iron bearing box is visible in the northern wall, to the west of the steps up to the engine house (Plate 114). This has large sandstone pads beneath, and a cast-iron beam running from the box above the extant axle housing to the west (Fig 108). A further, smaller, blocked cast-iron bearing box, lay beyond the extant axle mounting in the north-west corner (Plate 93).

Plate 114: A blocked cast-iron bearing in the northern wall

4.19.9 A large cast-iron bearing box and bracket in the south wall (PBLG9; Plate 115), opposite the engine house door to the north, and centred 2.76m from the east wall represents an end bearing for a line shaft through the blowing room, which also house a bevel gear for an upright shaft, placed on the opposite side of the wall within the 1836 weaving block (*Section 4.20.2*).

Plate 115: A large cast-iron bearing box and bracket in the south wall

4.19.10 ***Ground Floor:*** the ground floor of the preparation block originally comprised a mixing room (*Section 3.6.7*), and has been remodelled into offices, with the insertion of partition walls and a suspended ceiling, obscuring what is probably another barrel-vaulted ceiling to the flat roof. As on the ground floor, it has an enlarged southern bay, forming a store, to the east of a partitioned corridor that runs along the eastern side of the present structure (Fig 108 and 109). The bull-nosed windows of the second to fifth bays are similarly blocked as those on the ground floor, with the penultimate two bays from the north end, retaining replacement 16-light timber frames.

4.19.11 The 0.69m wide entrance to the spiral stair from the floor below is also bull-nosed and was latterly blocked with clinker block walling (Plate 109). The three southern bays retain visible columns, similar to those of the ground floor, and are placed directly above, presumably socketed into their heads. The remaining bays almost certainly retain similar columns, although they are no longer visible.

4.19.12 Access to the first floor was originally from the spiral stair, but another point of entry was also inserted from the earlier weaving block to the south via a short stair, although the date of this insertion is unclear. Access was also inserted into the projecting southern bay from a straight timber stair from the yard below (Fig 108).

4.20 WESTERN RANGE: 1836 WEAVING BLOCK

4.20.1 ***External Fabric:*** the 1836 weaving block is a two-storey structure to the south of the preparation block. It is of 12 bays, measuring 33.30 x 7.45m on a north-south alignment and initially appears to represent a single phase of construction. However, butt joints in both the east and west walls, and a full-brick thickness internal partition demonstrate that the southern two bays (WNG11 and 12) represent an extension to the structure (Figs 95, 103, 151 and 152; Plates 106 and 116).

4.20.2 ***Lower Ground Floor:*** the lower ground floor (Figs 98-99) has steps down into an entrance lobby from the courtyard to the east, in the central bay (WNLG5) of the original build, through a round-headed doorway. A 1½-brick thickness wall on its southern side extends 1.83m into the building, and is clasped by a tie rod. A similar wall at the opposite side of the adjacent bay suggests that a hoist drop was positioned in this bay (WNLG6), adjacent to the east wall, for loading materials to and from the reduced floor level. Modern single-skin brick or clinker-block partitions form two modern classrooms and a store, but the original construction appears to have been open-plan, with timber ceiling beams spanning the full width of the narrow structure unsupported. The ceiling beams, ceilings and joists were all replaced during refurbishment, but appear to replicate original positions, although blocking around the beam ends suggests that the original beams were of larger scantling, set in wider sockets within the wall.

Plate 116: The external eastern elevation of the 1836 Weaving Block

4.20.3 Each bay has a 30-light window with rolled sandstone sill, the lower 20-light panel being removable (Plate 106). The north bay of the east wall (WNLG1) retains a door, presumably originally with internal steps to the end of the courtyard, although these have been overlain with an access ramp. In the north wall, adjacent to the doorway, two ribbed cast-iron brackets are set vertically within the wall face (Plate 117). Offset slightly to the west, retained within the repaired ceiling construction, is a 1.30 x 0.61m hexagonal cast-iron bearing mount, projecting from corbels housed within the north wall (Plate 117). It is supported at its southern edge by a 0.13m diameter hollow cylindrical cast iron column, with ribs to a 0.3m diameter circular head plate. This is of late-nineteenth century style, and appears to form the housing for an upright shaft between the floors. Heavy repainting of the wall obscures detail, but there appears to be an area of blocking immediately adjacent to the bearing, and presumably this originally housed a small bearing for a line shaft from the engineering shop, from where the power was almost certainly supplied.

4.20.4 The tailrace for the New Mill water wheel passes beneath the northern three bays (WNLG1-3). This has a wide-arched face within the sandstone foundation wall of the western elevation, which appears continuous along the river bank (Fig 99; Plate 106).

Plate 117: A cast-iron bearing supported by a cylindrical cast iron column

4.20.5 The original timber ceiling beams survive in the southern five bays of the structure (WNLG6-10) (Figs 98-99) (Plate 118), and retain bolt hole pairs forming evidence for line shafting. The beams are supported by late brick piers, extending into the room to the position of the earlier line shafts. Two further shaft positions were observed on either side of the centre line of the building, suggesting that four line shafts were installed, possibly powering looms. The original beams were further supported by an assortment of columns, presumably salvaged from elsewhere within the complex, and which were inserted at a relatively late date, with either one or two columns placed beneath each beam (Fig 98).

4.20.6 The south wall of the original build is of brick, forming a return before an extension, comprising two bays (WNLG11 and 12), was added. It was of similar construction style, but with an increased thickness within the southern and eastern walls (Fig 98). It has only half-windows at lower ground-floor level on the east face, opening into the sloping courtyard (Plate 116), and was heavily remodelled internally, with tile floors and internal partitions to offices and toilets on the upper floor.

4.20.7 ***Ground Floor:*** the ground floor of the original build of the weaving block has windows to each bay, similar to those in the main mill, comprising 30-light timber windows, with the lower 20-light panel being removable (Plates 106 and 119) (Figs 105, 106 and 107). These have internal rolled sandstone sills, projecting slightly beyond the white-washed wall face, below replaced concrete lintels; above these the wall heads have been rebuilt.

4.20.8 The king post trusses have bolted and bracketed joints, with angled braces between the two trenched purlins to each pitch (Plate 120). The rafters are boarded, obscuring the head of the king post and the ridge, although the jowled head suggests that it is clasped. The first floor retains 195mm wide transverse timber plank flooring, nailed to the joists below, and probably original. The area is presently used as a staff canteen, with some partitioned offices at its southern end.

Plate 118: The original timber beams in the southern five bays of the weaving block, supported by later reused columns

Plate 119: The 30-light timber windows of the first floor

Plate 120: The king post trusses with bolted and bracketed joints and angled braces

4.21 WESTERN RANGE: 1839 WEAVING BLOCK

4.21.1 ***Introduction:*** after the success of the initial powered looms, a second weaving block was constructed to the south of the 1836 weaving block. It is of three storeys and 10 bays, measuring 29.7 x 6.3m, upon a north-south alignment and with a half-basement on the river frontage below, behind a sandstone façade (Plate 121). The building has been heavily modernised, comprising offices, a restaurant, kitchens, and a conference centre, obscuring almost all of the internal detail of the structure.

4.21.2 ***External Fabric:*** it is constructed of four-stretcher English Garden Wall bond, hand-made, mould-thrown brick construction, with windows to each bay on all floors, below a hipped roof above a parapet wall. These comprise 35-light windows with upper tilt openings to the taller ground floor windows, which are capped with sandstone lintels, and with 30-light windows on the lower ground, first, and second floors (Figs 104-5, 137, 149 and 150). The eastern façade has a loading door in the third bay from the south end of the first floor (WSF8) (Plate 122) and also in the fourth bay at second-floor level (WSS7) (Plates 84 and 122: Fig 149). This, and a further door in the northern bay (WSS1) (Plate 123), leads onto inserted raised gantries, connecting the weaving block to the Greg Rooms, the New Mill hoist and the Stable Block.

Plate 121: Western side of the 1839 Weaving Block

Plate 122: Eastern facade (southern end) of the 1839 Weaving Block

Plate 123: Eastern facade (northern end) of the 1839 Weaving Block

4.21.3 On the eastern side of the fourth, eighth, and northern bays, three rectangular brick towers project from the eastern external wall to first floor ceiling height (Fig 149; Plates 84 and 123). Each measures 1.31 x 0.77m, and is of four-stretcher English Garden Wall bond construction, presumably with a hollow central flue within walls of a full-brick thickness. The top of each tower has been rebuilt and each is capped with lead flashing, suggesting that each has been reduced in height, although there is a lack of wall scaring for any additional height on the second floor above any of the towers (Plates 84 and 123). The northern two towers have an I-section rail spanning between them, two courses below the capping, and this forms the base of the inserted timber and steel raised gantry. A similar beam was placed against the wall below the southern gantry (Fig 149; Plate 84).

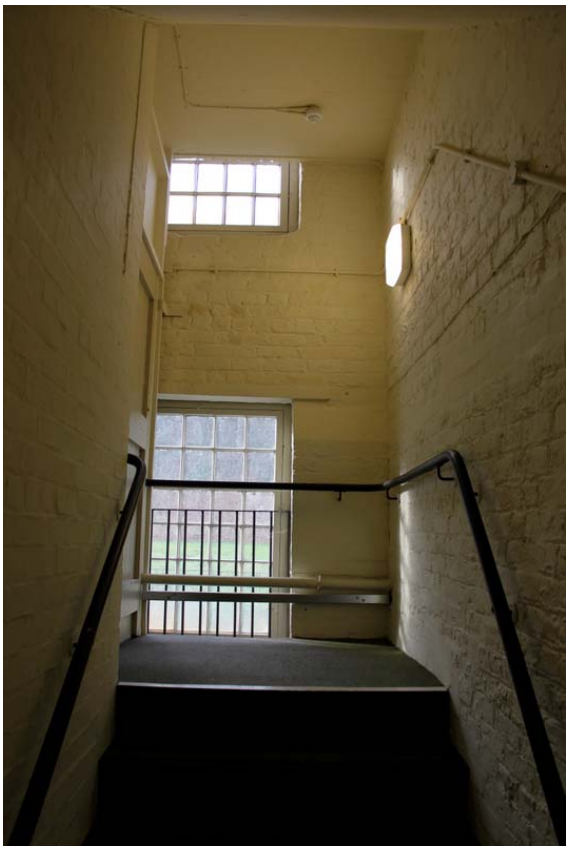
4.21.4 No internal apertures into the towers were observed internally, although the walls were generally obscured at both floor levels, and it is probable that they represent heating towers, incorporated into the original design of the structure to allow warmed air to be vented onto each floor to keep the temperature at an ideal heat and moisture content to reduce breakage of the cotton during weaving. It is unlikely that the towers each contained internal stoves at ground-floor level, as this would have generated soot within the loom room, and it is more likely that warm, moist air was piped from the original boiler via a culvert beneath the courtyard.

4.21.5 At the southern end of the structure, a two-bay wide rectangular block, measuring 4.55 x 1.85m projected up to first-floor height (Plate 124). Small windows in its external face at first-floor level, and block vents in a similar position below, strongly suggest that the structure formed a privy to the Weaving Block, although no internal inspection was possible to verify this.

Plate 124: Eastern elevation of the 1839 Weaving Block

4.21.6 ***Lower Ground Floor:*** the lower ground floor comprised a half-basement, terraced into the hill slope to the east, and constructed to a width of 4.87m, with transverse brick-vaulted ceilings to each bay (Figs 96-7) that were of 2.72m width. These were shallower than those in the blowing room of the Preparation Block at the northern end of the range (*Section 4.19.6-7*), and comprised a single inverted T-section iron beam, socketed into each wall. The brick arches remain exposed (Plate 125), and bear no evidence for tie-rods between the beams, although these were almost certainly included within the fabric of the arch, as observed in the Preparation Block. The majority of the bays were obscured by industrial fridge and freezer units, inserted along their length, and access via a corridor adjacent to the west wall. The northern two bays (WSLG1 and 2) were heavily remodelled for the insertion of a stair and lift shaft, with banded rebuilding of the elevations in the position of each floor level (Plate 126). However, a doorway at the northern end of the associated corridor, into the extension of the earlier weaving shed appears original (Plate 127); it has a shallow segmental brick lintel carried on a cast-iron plate. A brick-blocked doorway in the wall above (Plate 128), at ground-floor level, does not appear to represent remodelled windows within the original construction, suggesting that open access between the two weaving blocks was incorporated into the construction of the southern block, effectively creating larger loom rooms at ground and first-floor levels. The north wall also has an extant window, in the eastern part of the second floor, overlooking the weaving block to the north (Figs 96-7). This retains a 30-light, timber window, with removable 20-light panel, and tilting upper section, similar to those of the east and west walls (Plate 129).

Plate 125: The exposed brick vaulting without tie-rods in the Lower Ground Floor



Plates 126 and 127: Banded rebuilding of elevations as a result of the insertion of a stair (left). An original doorway at the north end of the corridor affords access to the earlier weaving shed (right)

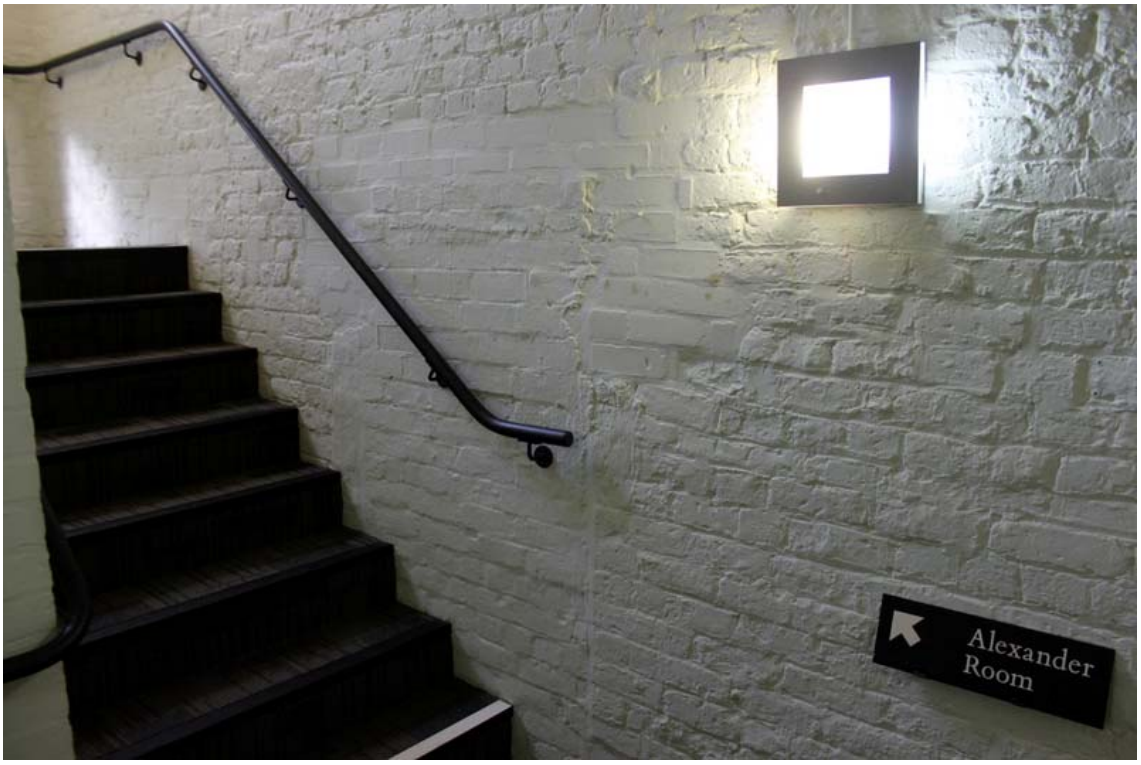


Plate 128: A brick-blocked doorway at ground-floor level

4.21.7 ***Ground Floor:*** at ground-floor level, the internal structure has been remodelled into a restaurant and kitchen, with strengthening of the ceiling (Plate 130). The timber ceiling beams have riveted metal plates to their soffits, socketed into the outer walls, and these are supported by 0.12m diameter hollow cylindrical columns with large plain ribs to a head-plate that clasps the beam above, and has rolled astragals above and below the rib (Figs 104-5). The beams carry 0.11m wide timber joists, on 0.50m centres, visible across the room, which has late stud partitions forming the restaurant and kitchen areas (Plate 132).

4.21.8 Half-turn staircases with brick spine walls were inserted into each end bay, adjacent to the west wall, and a lift shaft was inserted into the adjacent bay at the northern end of the structure (WSG2) (Fig 105). The bay to the south is spanned by a whale-backed, T-section beam at ground-floor level (WSG3) (Plate 131), it being bolted to the soffit of the replaced ceiling beams. To the south of the lift shaft, two rows of trimmer joists, bolted to the face of the ceiling beams with channel-section hangers (Plate 132), ran the length of the structure down the centre of the eastern longitudinal bay. A further row of trimmer joists was placed centrally within the western longitudinal bay. A timber beam also spanned from the south-east corner of the brick-built lift shaft to the east wall (Fig 104).

Plate 129: An example of a 30-light window in the northern elevation

Plate 130: The strengthened ceiling in the present restaurant

Plate 131: The southern bay is spanned by a whale-backed, T-section beam at ground-floor level

Plate 132: Two rows of trimmer joists, bolted to the face of the ceiling beams, ran the length of the building

4.21.9 ***First Floor:*** at first-floor level, the original timber beams survive *in situ*, and are supported by a row of slender, 0.08m diameter hollow cylindrical, cast-iron columns offset 0.5m to the eastern side of the centre of the structure (Figs 112-3). These have simple ribs to a flat head plate, with all of the exposed beams retaining bolts in their southern faces, 1.40m from the east wall, and which almost certainly indicate the position of a line shaft. A timber flitch plate on the southern side of the seventh beam (WSF3/4) from the southern end has a rebate and wear marks from a drum, 0.30m to the north of the projecting bolt, suggesting that the shaft was placed on the inner face of the hangers. Where a suspended ceiling was not present, 0.13m wide horizontally-set joists were observed, placed on 0.39m centres.

4.21.10 ***Second Floor:*** the second floor is similar to that below, but is open to the rafters, which are concealed beneath plaster board. Each bay houses a truss (Plate 133), unlike in the other structures, where the trusses are spaced wider on the upper floor. These comprise king post trusses, similar to those utilised elsewhere, with angled braces to the upper of the two trenched purlins of each pitch (Plate 133) with additional wing braces to the lower purlin from the tie beam (Figs 119-120 and 166). The fifth truss from the southern end (WSS5/6) has a timber strengthening corbel with steel brackets supporting its eastern end (Plate 134), whilst the seventh beam (WSS3/4) has a similar support at its western end. The beam to the north (WSS2/3) retains fireproof metal sheet cladding at its western end, suggesting that this was originally present throughout the structure. The seventh and eighth bays (WSS3 and 4) have several trimmers on the eastern side forming a supportive frame, and a more substantial trimmer in the northern bay (WSS1), may relate to an external hoist, and has a notched cleat on its eastern face (Plate 135).

Plate 133: One of the king post trusses, with angled braces to the upper of the two trenched purlins

Plate 134: The fifth truss from the southern end has a timber strengthening corbel with steel brackets supporting its eastern end

Plate 135: The roof beam the northern bay has a substantial trimmer that may relate to an external hoist, and a notched cleat on its eastern face

5. DISCUSSION

5.1 THE EARLY DEVELOPMENT OF THE FACTORY-BASED COTTON INDUSTRY IN NORTH WEST ENGLAND – THE CONTEXT FOR QUARRY BANK MILL

5.1.1 England's status as a leading manufacturer of textile goods on a world stage can be traced to the medieval period, when woollens formed the nation's largest export commodity (Ponting 1970). During the fifteenth century, the nascent linen industry began to take root in south Lancashire, using flax imported from Ireland via the port of Chester (Higham 2004, 196-7). The weaving of woollens and the production of linen remained important trades in north-west England throughout the sixteenth century, when silk and mixed fabrics classed as small wares and fustians (*Appendix 1*) started to gain popularity, with cotton frequently forming the weft in the latter fabric; the earliest known reference to cotton in the region dates from 1601, when it is mentioned in the will of a Bolton fustian weaver (Wadsworth and Mann 1931, 15).

5.1.2 At the beginning of the eighteenth century, the English cotton industry was still comparatively small. Most cotton materials were imported from India, but in 1701, and again in 1721, Acts of Parliament were passed which prohibited the wearing of Indian calicoes. These measures were aimed at assisting the English woollen industry, although it was actually cotton manufacturers that benefited. The benefits were, however, slow to be realised because of two limitations: the restricted supply of raw cotton; and the slowness of hand-spinning. The supply of raw cotton did improve during the eighteenth century, first from Levant, then from the West Indies and, after, 1783 from North America (Holland 1976, 39).

5.1.3 During the second half of the century, the technical revolution in the cotton-spinning industry was largely responsible for the dramatic change to the economic and social structure of the region. Improvements in the spinning process began with the introduction of James Hargreaves' spinning jenny in 1764, whereby a single worker could operate eight spindles simultaneously. Five years later, Richard Arkwright took out a patent for a water-driven spinning machine, called the water frame. The success of this machine enabled Arkwright to establish England's first cotton factory at Cromford, near Derby, in 1771. This venture proved to be an enormous success and, by 1780, there were between 15 and 20 water-frame factories being operated by Arkwright and his partners, or by proprietors acting under licence (Edwards 1967, 4).

5.1.4 Arkwright's invention was improved upon by Samuel Crompton, who introduced the spinning mule in 1779. This machine combined the best features of the jenny, which made thin thread, with those of the water frame, which made strong thread. By using the mule, English spinners were able to make thin, strong thread from which fine cotton goods, such as muslin, could be manufactured to compete with those made in India.

5.1.5 During 1790, 1791 and most of 1792, the cotton trade was expanding in boom conditions (Edwards 1967, 11). However, the ever-increasing prospect of war with France in 1792 caused a decline in the trade, and the declaration of war in 1793 accentuated difficulties and resulted in a contraction in trade with Europe. However, the effects were offset quickly by the rapid growth of exports to America, and the cotton trade emerged from the crisis by the end of 1793 (*op cit*, 12). A rapid expansion of exports continued until autumn 1796, when problems occurred as the export markets were well-stocked and merchants became reluctant to give large orders until they knew the outcome of peace negotiations with France. More significantly, there was an increasing scarcity of money, and in February 1797 the Bank of England suspended cash payments (*ibid*).

5.1.6 The economic difficulties continued into the first half of 1798; in January 1798 mule spinners' wages were reduced in the Manchester region, and many firms were selling yarn at great discounts, largely due to surplus capacity (Edwards 1967, 12). By June 1798, however, the trade had made a remarkable recovery and cotton imports increased rapidly and exports soared, particularly to the North American and Caribbean markets. Another set-back in autumn 1799 was initiated with a bad harvest that necessitated large imports of grain. The crisis was over by the beginning of 1800, and imports of cotton reached a new record peak (*op cit*, 14).

5.1.7 In October 1801, the preliminaries of peace with France were signed, and resulted in a period of very rapid expansion; 1802 saw spinners enjoying peak profits. However, the trade over-reached itself, and resumption of war in 1803 halted the burst of factory building (*op cit*, 15). The trade in general continued to be uncertain and fluctuated throughout 1804-05, although yarn exports continued to grow and soared to record levels in 1805, causing the price of yarn to rise. By this time, both spinning and weaving were carried on in almost all of the emerging textile-manufacturing towns that formed a wide belt encompassing the principal marketing centre of Manchester (Catling 1986, 116). The growth of the export trade, especially to Europe, continued during the second decade of the nineteenth century. The export of twist and yarn, for instance, rose from £794,465 in 1812 to £1,119,850 in 1814, and then to £2,022,153 by 1820 (Lee 1972, 57).

5.1.8 Quarry Bank Mill had been designed to produce coarse warps using Arkwright's patented water frames. Whilst there is evidence to suggest that Samuel Greg also used using spinning mules that were capable of producing finer yarn, it is not known whether this was produced at Quarry Bank, or in another of the family's mills. Low counts of yarn certainly remained the principal output from Quarry Bank Mill throughout the nineteenth century, and when weaving was introduced this was of coarse calicos (Rose 1977, 156).

5.1.9 The onset of the American Civil War caused severe problems for the English cotton industry as the blockade of America's southern ports by the Federal navy cut off the supply of raw cotton on which the regions mills depended. This resulted in the Lancashire Cotton Famine of 1862-64. During this period, raw cotton increased in price from 9d per lb in 1861 to over 2s in 1863 (Holland 1976, 142). Mill closure, short time working and mass unemployment resulted; by November 1862, three fifths of the labour force were idle.

5.1.10 The region surrounding Manchester dominated the English cotton industry into the twentieth century; during the early years of the last century, it has been estimated that some 76% of the cotton operatives in the United Kingdom were within the Manchester / Lancashire area (Chapman 1905, 37). The cotton industry reached its peak in 1914, with India, the largest single customer, buying 3000 million yards of cotton cloth (Holland 1976, 142). Despite cotton remaining as Britain's leading export until 1938, the industry declined rapidly between the wars, largely through a fall in exports. Countries that had formerly provided lucrative markets, and particularly India, developed their own mills. A short boom period began in 1945 as a result of shortages caused by the war, but after 1952 British cotton textiles faced intense competition from manufacturers in the Far East. More serious, however, was the widespread manufacture of man-made fibres; by 1962, 40% of British cloth production was in man-made fibres (Holland 1976, 278). In consequence, the British textile industry largely collapsed during the second half of the twentieth century.

5.2 THE DEVELOPMENT OF QUARRY BANK MILL

5.2.1 ***Context:*** Quarry Bank Mill was amongst the first wave of cotton-spinning mills to be established in the Manchester textile district during the last quarter of the eighteenth century, and the first to have been put into production in Cheshire. Richard Arkwright's short-lived mill at Birkacre, near Chorley, is widely acknowledged to have been the first cotton mill in the region, being established in 1778, but this was destroyed by rioting during the following year, which led Arkwright to focus his attention back to Derbyshire (Aspin 2003, 452).

5.2.2 The main market for the Cheshire cotton industry during the late eighteenth century was Manchester and Glasgow (Calladine and Fricker 1993, 38), and several water-powered cotton mills were built in these rapidly expanding towns during the early 1780s. These included: Bank Mill on the River Irwell at Salford, which was opened in 1782; William Douglas' Pendleton Mill, utilising a former corn mill on the River Irwell, was producing cotton yarn in 1782; Garratt Mill on the River Medlock in 1783; William Edge's Mill Hill Mill on the River Irwell in 1783; and David Holt's Beswick Bridge Mill on the River Medlock in 1784, which expanded in 1790 to become Holt Town (Aspin 2003). The most significant mill of this pioneering period in Manchester, however, was perhaps that established by Richard Arkwright at Shudehill in 1780-2 (Williams with Farnie 1992). This was one of the largest Arkwright-type mills built, following the typical design of Richard Arkwright, comprising a narrow, rectangular, multi-storey structure of non-fireproof construction, with an external stair. The particular significance of this mill, however, is that the power plant was at least in part steam powered, signalling the viability of an alternative power source to flowing water, which ultimately enabled new cotton mills to be built on planned, compact sites within an urban setting.

5.2.3 The majority of contemporary mills erected for the growing cotton-spinning trade in east Cheshire were also located in the expanding urban areas, such as Congleton and Macclesfield, adjacent to rivers and streams (Calladine and Fricker 1993, 138).

5.2.4 ***Phase 1 - The Old Mill (1784-1796):*** the site chosen for Quarry Bank Mill was dictated by the availability of water power provided by the River Bollin, and was associated with a small village, Styal, that housed the working population and which expanded alongside the development of the mill. On one level this was comparable to the early development of the factory-based textile industry in the Manchester area, as the earliest mills on the fringe of the expanding towns of Stockport, Manchester and Salford were water-powered. An interesting component of the Quarry Bank Mill site, however, is the scale of the family home almost adjacent to the mill, which reflects a rapid expansion in the fortunes of the family from an early date. This meant that by the early nineteenth century the mill formed part of the estate of a Georgian country residence of a wealthy family, and served as a great showpiece. There are other examples in the region, however, of impressive cotton mills that were set within large country estates, such as Samuel Oldknow's Mellor Mill. This huge water-powered mill was completed in 1795 and, like Quarry Bank Mill, was designed to spin coarse counts of yarn on water frames.

5.2.5 The earliest phase of Quarry Bank Mill (Fig 173: 1a), completed by September 1784 (*Section 3.3.1*, above), followed the Arkwright-type principle, and is one of the earliest surviving examples of such a structure in the North West of England. Although being only 27.3m in length, compared to the massive 60.9m length of Shudehill Mill (Williams with Farnie 1992), it was of a more typical 8.3m internal width, and apparently of four storeys height. The width of the building was probably designed for Arkwright's patented water frames and carding engines, which were installed initially (Calladine and Fricker 1993), but it was also of sufficient dimensions to house spinning mules, which could be placed transversely across the width of the mill. Furthermore, the outer walls could be spanned by single, large-scantling timbers, carrying the floors above, and forming the tie beams of the trusses; even though English Oak was becoming scarcer by this date (Miller and Wild 2007, 97), a trade in the import of high-quality pine from the Baltic ports had become established by this date. The extensive use of fireproof sheeting and heavy painting has not made it possible to establish the timber used within the construction of the earlier elements of Quarry Bank Mill, and specialist timber sampling in the future would prove useful. The documentary sources reveal the purchase of timber for the construction of the mill, as early as 1783, and including oak planks (*Section 3.3.1*, above), suggesting that all the structural timbers are possibly also of oak.

5.2.6 Typical early mills within the area had the single rectangular block form of the Old Mill and were of utilitarian design, but with Flemish Bond brickwork to public facades (Calladine and Fricker 1993); Quarry Bank Mill differed in that it had English Garden Wall bond construction throughout. As mentioned previously, external stairs were typical of Arkwright-type mills, although there were examples, such as Kirk Mill in Chipping, that had an internal stair; Despite there being no mention of the stair tower prior to the nineteenth century, it is keyed into the main mill, and shows no evidence for being a later addition. The stair tower has significant architectural detailing, and while it is possible that this was added if the tower had been remodelled to house a stone replacement of an original timber stair, but given the complete lack of evidence for an internal stair, it appears likely that the external stair tower provided access to all floors of the Old Mill from the outset.

5.2.7 Many of the Arkwright-type mills, though not exclusively so, were erected with a privy tower. There is no documentary evidence prior to 1822 for the privy tower on the west side of the Old Mill, and earlier accounts suggest that the soil from the privy tower was carried away in the mill leat (Calladine and Fricker 1993). However, there is no physical evidence to suggest that the privy tower is anything other than an original feature. Located at the south-west corner of the mill, and away from the leat, it is plausible that the soil collected from the privy tower was dumped into the river or was collected as fertiliser. It is noteworthy that the privy tower incorporated a well-built collection opening that was associated with a dry chute (Plate 10), and was a form that was copied locally at Brooks Mill, Congleton, in a privy tower built in 1835 (*op cit*, 83).

5.2.8 Fireproofing within the earliest phases of the mill was minimal, as with most late eighteenth-century textile mills, despite the fact that the preparatory phase of cotton spinning produces extremely flammable material. Lath and plaster covering of the ceiling provided a rudimentary form of fire prevention, and this can be seen in several areas within the Old Mill. This was enhanced by the use of metal sheeting, which could be attached to any exposed timber to make it more resistant to fire. The Mill Memoranda specifically describes the sheeting of the floors, and although none of this survives, plenty of iron sheeting, nailed onto the ceilings and beams, does survive. This has been observed elsewhere throughout the region, notably in the Old Mill (1798) of Murrays' Mills in Manchester (Miller and Wild 2007).

5.2.9 The original mill was water powered, and whilst it would appear simplest to have placed a water wheel directly in the River Bollin, on the western side of the mill, Smeaton's extensive research in the 1760s had demonstrated that overshot and breast-shot wheels were not only less susceptible to low water levels, but also provided a greater power efficiency.

5.2.10 In order to achieve a suitable head of water for a breast-shot wheel, a headrace, supplying water from upstream, was placed along the eastern side of the mill. An external gable, or end bay position would appear ideal for such a wheel, allowing maximum use of internal floor space, and providing the simplest form of primary motion shaft from the axle of the wheel down the full length of the mill. The substantial stone structure within the 1853 boiler house, with a possible axle mount at its head would appear to predate the boiler, and thus offers a potential site for an original external wheel. However, its raking walls would have been unsuitable for the side walls of a wheel pit, as water could bypass the wheel buckets, and furthermore, the height of the putative axle mount is too high, relative to the headrace, to house anything but an undershot wheel, which is unlikely to have been employed in a mill of this size and date. It is possible that further physical evidence to support or refute the presence of an early water wheel in this position may survive concealed behind existing fabric. This should be borne firmly in mind during any future repair or reconstruction works in this area.

5.2.11 The wheel was instead placed internally within an open wheel pit in the fourth bay from the north end of the Old Mill (OMLG4), adjacent to the stair tower, with the tunnels for both headrace and tailrace presumably excavated during the earliest stages of the construction of the mill. The original wheel would have been of timber construction, and even though its axle was placed below floor level within the basement of the mill, in order to help achieve the necessary head of water, its axle would have probably formed the primary drive shaft. The documentary evidence demonstrates that by 1834, an upright shaft was placed in the Old Mill in a position against the original south wall of the Old Mill (Figs 12, 16-18, 25, and 26), and this probably represents its original position, on an alignment with the shaft of the water wheel. It is doubtful that the primary motion shaft ran the length of the mill in a duct below floor level (although this is not unprecedented, as shafting was placed between floor levels at McConnel and Kennedy's Ancoats mill in the early nineteenth century), with a large gear wheel almost certainly being placed in an adjacent pit, transferring the power to a much smaller wheel on a longitudinal shaft, not only elevating the height of the drive shaft, but also greatly increasing its rotational speed. Documentary accounts suggest that the wheel was replaced in 1792 (*Section 3.3.5*), and again comprised a timber wheel, possibly with some elements of iron, although the Mill Memoranda clearly states that the iron wheel of 1796 was '*the first one ever attempted*' (*Section 3.4.1*). The internal power arrangement within the mill was heavily modified throughout its history, not only as the mill expanded, but also as steam power and new machinery was introduced, and was subsequently relocated. Further changes were implemented with the introduction of a rope drive system in the early twentieth century, and finally with a reconstruction of a shafted system during the refurbishment of the mill at the end of the twentieth century. Bolt-holes, drum scars, brackets and cutaways in many of the beams within the Old and New Mills represent elements of line shafting, with several positions of shafts within the Old and New Mills having clearly been identified within the survey (*Section 4*). However it is almost impossible to attempt to phase these, as there is no stratigraphic correlation between the shafts, which all ran longitudinally. The documentary evidence demonstrates that by 1834, an upright shaft was placed in the Old Mill in the position of the original south wall (Figs 12, 16-18, 25, and 26), and this probably represents its original position, on the opposite gable to the original water wheel, and apparently was on an alignment with the shaft of 1792.

5.2.12 A bearing box and external gear wheel at first-floor level in the north wall of the Old Mill was placed directly above the position of the 1835 engine, and it is therefore likely that power was supplied directly to the first floor from the primary motion shaft from this date. This clearly highlights the difficulty in trying to phase a piecemeal and constantly adapting power system, based on drawings and limited physical information.

5.2.13 The roof of the Old Mill presently comprises seven king post trusses, set wider apart than a standard placement at bay divisions. It is not clear whether this arrangement represents that originally employed, or whether fewer trusses were deemed necessary when the roof was raised during the extension of the Old Mill (*Section 5.3*).

5.2.14 No physical evidence survives for the internal machinery layout of the original mill, which was described as being 'equipped with machines and devices for carding, roving, spinning and manufacturing cotton and cotton material' by 1st September 1784 (QBM A12). Further sources referred to *'spinning', 'carding', 'reeling' and 'making up rooms'*, with the water frames having around 2500 spindles (*Section 3.3.2*). This in itself is of interest, as it reflects a considerable speed at which the mill was equipped with machinery; some mills of this period were slow to come into full production, for example Arkwright's Shudehill Mill was only partially equipped with spinning machines some seven years after it had been constructed (OA North 2014), which was attributed in part to the limited availability of machinery.

5.2.15 ***Phase 2 - The First Extension (1796-1817):*** following the success of the first mill, it was extended on its southern side in 1796 (Fig 173: 2a). On its western face, the joint between the two structures is obscured by the original privy tower, whilst on the eastern façade, careful construction minimised the visual impact of the joint between the two structures, it mainly being obscured within window apertures, but with vertical butt-joints between the two phases of construction being barely visible between the floors. Internally, the joint is far more visible, with the later structure being a full skin of brick narrower, and with an awkward plaster render attempting to smooth this joint. Although factory building was still in its infancy by 1796, a greater depth of experience in the construction of these large structures had been accumulated since 1784, and this is reflected in the narrower, and hence much cheaper and more rapid construction of the thinner walls of the extension to the Old Mill.

5.2.16 The 11.8m long extension brought the overall length of the mill to 39.5m, adding a further five bays to the south, with the adjacent end bay of the original mill, being slightly wider than the others (Fig 116). Privy and hoist towers were also included within the west wall of the new structure (Fig 173: 2b), although neither is mentioned in the documentary sources until 1822 (*Section 3.4.5*). The documentary evidence records that an additional floor was added to the existing mill at this time (*Section 3.4.1*). The use of similar materials and styles of construction makes this very difficult to identify within the physical remains, although the window apertures differ from those below, being slightly shorter, at 1.48m, as opposed to the 1.71m high windows of the floors below. Diminished window height was a standard architectural technique of the period, but this was not employed within the original construction, where all the windows were of similar height. Within the raised extension of Old Mill, the apertures retained the same external appearance as those below, with the reduction only comprising the height from sill to wall-head.

5.2.17 Other than a difference in wall thickness, a change in roof structure provides a clear distinction between the two phases of construction. Rather than using king post trusses, as in the earlier part of the Old Mill, the extension incorporated two queen strut trusses, placed on similar spacing to those within the original fabric, but marking a relatively early example of an evolution of roof construction that allowed the attic to be more easily used, having a central, open raised aisle, rather than sloping spaces flanking a central post.

5.2.18 The difference between the two roofs demonstrates that the upper floor was not simply added across the enlarged building once construction had reached second-floor height, with new trusses throughout, but that the majority, if not all of the original roof construction was re-used when the new floor was added. Although the butt-joint visible at lower levels between the two phases of the Old Mill is obscured above the upper floor windows, where the parapet has been rebuilt (Plate 2), the roof still retains a very distinct joint between the original and extended parts of the Old Mill, demonstrating that the upper storey was added separately to the erection of the five-bay extension to the original mill. Without removing the flooring of the upper floor, it is not possible to establish whether the trusses were hoisted up to the new roof level, which is the more likely option, or whether the original tie beams of trusses to each bay, were left to form ceiling beams of the penultimate floor, and new tie beam were added to house a reduced number of rebuilt trusses above.

5.2.19 The extension to the Old Mill in 1796 incorporated a second water wheel, presumably required to power the increased spindleage of the mill, which by 1818 was roughly double that in 1796 (*Appendix 2,* Table 1), and it would appear that the layout of the expanded structure provided for mule spinning on two of the four main floors (*Section 3.4.2*). This new water wheel was placed against the south wall of the Old Mill, and further to the east of that within the earlier structure, against the external wall of the mill, internally within the new extension. Whilst the pit for the water wheel was remodelled subsequently for the later insertion of a turbine, it was significantly smaller than the earlier wheel pit (Fig 99). The Mill Memoranda records from this date refer to the second water wheel as being of iron (*Section 3.4.1*), and the much smaller size of the pit does suggest that it housed a smaller, more powerful iron wheel.

5.2.20 It seems clear from the evidence available that the waterwheel installed in 1796 supplemented rather than replaced the earlier power system, with mention of two wheels in 1801, at which time *'iron pillars'* were also mentioned (*Section 3.4.3*), suggesting that some columns were being inserted into Old Mill by this date. This may have been in response to the larger, heavier, mules that were becoming available around the turn of the nineteenth century, as the spindleage of such machines was increasing at a rapid rate.

5.2.21 The spinning mules being produced in the late eighteenth century would still have been small enough to place transversely across the mill, with pairs placed back to back. The insertion of columns would not have affected the operation of mule spinning floors at this date, only becoming problematic when the mules became so large as to require longitudinal arrangement within the mill. Many columns of this date were of solid cruciform section, first used in the fireproof construction of Ditherington Flax Mill in 1796, and also within the New Mill of Murrays' Mills, Manchester in 1805. No such columns survive within the Old Mill, those present being of styles typical of the mid to late nineteenth century, suggesting several episodes of column replacement.

5.2.22 A boiler appears to have been installed prior to 1806. Given the small area in which it was placed, on the west external face of the northern end of the Old Mill, it was probably a vertical, haystack type. The boiler was replaced with a wagon boiler during the addition of a Boulton and Watt engine in 1810. Reference to its location near the 'Old Chimney' in the Mill Memoranda (*Section 3.4.10*), may reflect the existence of a heating boiler prior to the addition of a steam engine for supplementary power. Alternatively it may be an indication of the existence of an earlier engine prior to the Boulton and Watt engine, although firm evidence for the existence of any such engine is lacking.

5.2.23 The Boulton and Watt engine was placed to the north of the chimney, which was of typical tapering square section, and added in the angle between the mill and the northern side of an attached tower. This tower now has doorways to each floor, and was possibly used as a privy tower before its latter use as a storage tower. However, its proximity to the chimney, and presumably the original boiler, may be a possibility that it originally formed a heating tower, fed by steam pipes from the boiler, rather than from internal stoves. There is evidence for some concerns about the placement of the engine above the tailrace of the water wheel (*Section 3.4.9*), as well as the clear remodelling of the arch below the western wall and beyond (*Section 4.3.9*).

5.2.24 The documentary evidence demonstrated that further structures lay to the south and west of the Old Mill by the end of this phase, including a '*warehouse*' and '*Cleaning Cotton room*' (Scutching Room) to the west (*Section 3.4.11*), and workshops, possibly to the south of the mill (*Section 3.4.14*). No physical remains of the workshops were revealed, and several later structures were erected to form the present western range of buildings, removing all traces of any such early structures above ground. However, both tailraces discharge through arches within a dressed stone wall forming the eastern bank of the canalised River Bollin. This was certainly in place by 1810, and presumably formed the foundation for the western external wall of the warehouse and the preparation room. However, it is unlikely that they were of stone construction above this level, given the complete use of brick in the construction of all other buildings within the complex.

5.2.25 ***Phase 3a – The New Mill (1817-30):*** this phase represents a significant major expansion of the complex, reflecting the continued growth and prosperity of the region's cotton industry. The principal addition to Quarry Bank Mill during this period was a second, transversely-placed mill, called the New Mill, at the southern end of the already extended Old Mill (Fig 173: 3a). This comprised a 7 x 5 bay, rectangular wing, again of non-fireproof timber construction and dates to 1818-19. The new structure was a bold statement of prosperity, not only in terms of its size, but also in its architectural styling, which was much more polite than other mills of the period within the region (Williams with Farnie 1992). The mansard roof (technically a gambrel roof, although this term is not widely used) of the New Mill is unique within structures of the period within East Cheshire (Calladine and Fricker 1993), and allowed for much greater use of the attic, effectively creating a fifth floor.

5.2.26 The floors are carried on timber beams, each of approximately 13.5m in length, spanning the entire width of the building, and representing a significant investment in sourcing timber of this length and scantling. This again reflects the relative infancy of the engineering principles associated with construction of large factories, with the desire for wider structures to accommodate larger machines not being matched by appropriate technology, particularly outside of the main centres of development, such as Manchester and Stockport. The beams were supported by two rows of columns, and whilst these were vertically aligned through the mill, they were not interconnected to increase the structural stability of the building. Furthermore, the head plates of the columns, although relatively wide, offered no cradling of the beams or crush protection from the weight of the columns above. This is a stark contrast to contemporary pioneering work being undertaken elsewhere, such as at Murrays' Mills in Manchester, by William Fairbairn in 1817 (a former employee of Hewes, less than a decade earlier), where vertically and horizontally interconnected columns were inserted into the earlier mills and allowed for the flow of gas through the columns and between floors for the lighting system (Miller and Wild 2007).

5.2.27 Crush boxes, which comprised cast-iron collars, slid over the beams during construction and socketing the columns above and below providing rigidity and support, and were included in the New Mill at Murrays' Mills as early as 1805 (*ibid*), but were not used in the design of the New Mill and Quarry Bank. The principle of jointing the bifurcated foot of an upper column, on the head of a lower column, and physically attaching the whole vertical column row became standard later in the nineteenth century. This was incorporated into the design of a smaller block within the Murrays' Mills complex in 1822, only four years after the very crude construction of the New Mill at Quarry Bank, despite the engineering brilliance of Thomas Hewes, and the network of contacts that he possessed.

5.2.28 It is in contrast to the major textile centre of Manchester that the Cheshire mills still had little in the way of fire protection at this date. More substantive fireproofing measures were quickly adopted in Manchester in the early nineteenth century in response to fires. This entailed the use of brick-arch vaulting, on cast-iron beams, and staircases of stone, rather than timber. So while there may have been a substantial number of early timber stairs in Manchester, few survived in part because of fire, or were replaced because of the risk of fire, or due to building regulations during later refurbishment. The uptake of vaulting in East Cheshire was slow prior to the mid-nineteenth century, although the New Mill at Quarry Bank was constructed with a fireproof external stair tower, and if there was an original timber stair within the brick stair tower of the Old Mill, it had been replaced in stone prior to 1822. The tower also included a vertical standpipe for fire-fighting, possibly supplied by a tank on the roof of the tower, although no evidence for this survives. The pipe was replaced latterly with a mains-fed system, probably of early twentieth-century date, but no sprinkler system appears to have been installed to supplement this, which was common in mills of all types and sizes within the region, typically from the early twentieth century. A similar standpipe was also installed into the stair tower of the Old Mill.

5.2.29 Despite the apparent lack of technological innovation in the construction of the building of the New Mill, with the exception of its mansard roof, the original water wheel, designed by Thomas Hewes, and measuring 32' in diameter and 21' wide, represents a very early example of a breakthrough in waterwheel technology. The original wheels were of timber, although at least one was replaced with iron, but all had the drive being taken directly from the axle. However, this created great torsion forces, which, even with heavy spokes, often led to breakages. Hewes' suspension wheel placed within the New Mill is probably one of the earliest examples of their use in the country, with much of their development having been undertaken by Thomas Hewes, who installed one at Belper, in Nottinghamshire in *c* 1810.

5.2.30 The suspension wheel had slender iron spokes and was much lighter. One of its main advantages is that it could be fitted with a rim gear, with teeth around the circumference of the wheel that could drive a much smaller pinion wheel housed on a separate drive shaft. The pinion wheel was placed close to where the power was generated (near the water chute), for maximum torque, and to increase the rotational speed of the drive shaft significantly, due to the effect of gearing from a large to a small cog. It also removed the twisting effect on the axle, allowing it to be constructed with much more slender, and, thus lighter, spokes, requiring less energy for rotation, and less frequent failure.

5.2.31 The wheel had a rim gear which drove a pinion wheel, almost certainly placed to the west of the axle, unlike that now present to the east. Any evidence for a footstep bearing has been removed, but large cast-iron brackets placed adjacent to the dividing wall between the New and Old Mills on each floor, represent the remains of bearings that carried both the upright shaft, and associated bevel gears, translating the vertical drive onto horizontal drive shafts on each floor. The large extant bearings are unlikely to be those installed by Thomas Hewes within the original construction (*Section 3.5.1*), being of a style more typical of the late nineteenth century, and comparable to that observed in the later Spring Garden Mill in Colne, Lancashire, where very similar brackets represent an upright power-transmission system dating to the late 1870s (OA North forthcoming).

5.2.32 Following the construction of the new wheel, those within the Old Mill became redundant and were infilled, to allow the lower ground floor to be utilised more effectively. Excavation in 1995-6 recorded possible drains set into the backfill of the northern internal wheelpit. Given the documented use of this area of the mill in the 1820s and 1830s, these may in fact have been flues for the blowing machines in use here at that time.

5.2.33 As in the earlier phase, the documentary sources reveal that a continuous range of three buildings lay between the Old Mill and New Mill and the river by 1822 (*Section 3.5.10*) but, as with the earlier structures, nothing above ground level survives of their fabric, following significant remodelling in the following phase.

5.2.34 ***Phase 3c – Greg Rooms (1830-6):*** by 1834, a new block to the south of New Mill, presently known as the Greg Rooms, survives in a remodelled form. The original construction was in similar brick to the adjacent mills, and comprised a two storey, 6 x 2 bay rectangular structure, angled 7° to the west of the earlier structures, following the line of the track along the eastern side of the mill. It was of similar non-fireproof, timber construction to the New Mill, with the ceiling beams carried on a central row of columns in the northern four bays. The lower floor was heavily remodelled during conversion into toilets, and appears to have been used as a blacksmiths (*Section 3.5.15*). The first floor, however, retains internal brick partitions in the southern two bays (GRF5 and 6), demonstrating its use as offices and a counting house with external access from the raised ground level to the east, and representing good survival of relatively early ancillary buildings associated with the financial operations of a mill complex. Power was provided into the structure at the western side of the north wall, where a bearing box in the wall housed a drive shaft from the New Mill.

5.2.35 This structure appears to have had an external stair on its northern side, and certainly predates a single-bay structure, also shown on the map of 1834, and marked as a lodge on subsequent mapping of 1844 (Fig 42), and formed a link at lower ground-floor level between the blacksmiths shop and the New Mill stair tower (Fig 105).

5.2.36 ***Phase 4 – Powerlooms and Associated Development (1836-70):*** with the majority of the extant structures of the eastern part of the mill complex established by 1834, the next phase of construction relates to the company's diversification into power-loom weaving, which was implemented under the direction of Robert Hyde Greg. It is likely that Robert Hyde Greg's decision to adopt power-loom weaving on a permanent basis was in no small part due to the falling prices of yarn that characterised the late 1820s and 1830s. Prior to the construction of the first weaving block, however, an overhaul of the steam power plant was undertaken, necessitated by the increased requirements of powerlooms associated.

5.2.37 The new engine was provided by Boulton and Watt (*Section 3.6.4*), although it appears that the original wagon boiler was retained, which would have simplified the flow of exhaust to the chimney. It was housed in a new two-storey structure, of standard beam engine house design, placed transversely against the northern end of the Old Mill (Fig 173: 4a). A large cast-iron bearing box, cut through the north wall of the Old Mill, allowed for a primary motion shaft to enter the mill, where it could be connected to the shafting for the water wheel, using a simple clutch, no evidence for which survives.

5.2.38 Following the culmination of the development of a commercially viable powerloom in 1830 by Robert Roberts, weaving became a major mechanised industry, and many spinning concerns embraced the opportunity to diversify into the manufacturing branch of the textile industry. This signalled the emergence of integrated cotton mills, where cotton yarn was spun and wove at a single mill complex. Peter Ewart himself had been involved in the development of an earlier pneumatic loom, so the Greg's were presumably keen followers of the technological advances, and, recognising the potential benefits, began to install powerlooms in several of their mills.

5.2.39 The first weaving block at Quarry Bank Mill was apparently of two-storey construction, above a basement terraced into the hillslope to the east of the River Bollin, and was stylistically more reflective of a warehouse than a weaving shed. Indeed it could have in part also functioned as a warehouse; the basement terraced into the hillside would have been well suited as a conditioning warehouse, where spun yarn could be stored prior to weaving.

5.2.40 The weaving block (Fig 173: 4b) was placed to the south of a preparation block, opposite the New Mill, and survives as a 10 x 2 bay rectangular structure. Its narrow 6.5m internal width meant that columns were not necessary within the original construction, although several were later added, and light was provided by large windows in each bay, and was very different from the north-light skylights of the large, single-storey weaving sheds that came to dominate numerous industrial townscapes across Lancashire and Yorkshire in the second half of the nineteenth century; it remains uncertain precisely when the purpose-built north-light weaving shed was introduced to the region as a building form, although it was certainly not adopted widely until the 1840s. The weaving block was expanded within three years (Fig 173: 4c), with the addition of a further two bays at its southern end (WNG11 and 12). The end wall of the earlier structure was retained, suggesting that the extra bays were used as warehousing.

5.2.41 Given the success of the first weaving block, a second structure was erected within a short space of time on its southern side (Fig 173: 4d). This was in operation by 1839, and represented a further 10-bay structure of three storeys, above a half-basement, terraced into the hillslope. This basement represented the first use of brick-arched vaulting within Quarry Bank Mill, carried on cast-iron beams, instead of timber, and represented a form of fireproof construction that had become long-established in textile mills across the country, having been successfully installed within Ditherington Flax Mill, Shrewsbury as early as 1796, but was not widely adopted because of the considerable expense entailed with its construction.

5.2.42 The second weaving block was again of typical warehouse-type construction, comprising timber floor and beams, with large windows within each bay. The two extant staircases were inserted, with clear evidence in the adjacent walls for the extent of the original floors, leaving the position of the original communication between floors unknown. The documentary evidence indicates that the 1836 weaving shed had a floor added in 1842 (*Section 3.6.1*), which was removed subsequently at an unspecified date; however, this actually refers to the later shed. A two-storey privy block attached to the southern side of weaving shed also does not extend to the upper floor, but was not added until 1875, with a clear butt joint being visible within the external fabric.

5.2.43 The re-orientation of machinery throughout the complex associated with the introduction of weaving, resulted in a non-standard layout of the complex, compared to the more efficient design of the newer purpose-built integrated mills. This is typical of the early factories of the late eighteenth and early nineteenth centuries that were remodelled to remain viable.

5.2.44 In order to compete commercially, the mill had to expand and incorporate new technologies, but this often clashed with the aesthetic needs of the surrounding gardens and grounds. The weaving sheds of 1836 and 1839 demonstrate this perfectly. Both are of similar proportions to the main mill, comprising multi-storeyed rectangular blocks, typical of the cotton mills of the region.

5.2.45 It was certainly wise to make a first foray into powerloom weaving in structures that could be converted to alternative use had this proved unsuccessful. However, following the success of weaving, it may have proven more profitable to erect a large single-storey weaving shed, of the type seen in Lancashire and West Yorkshire. The land to the west of the River Bollin may have provided a suitable terrace for such a structure, but would have removed it from the available water power source and may have been a significant factor. Also there would have been a significant effect on the gardens and grounds, and it is possible that the mill was confined to the east of the river so as to be away from the vistas of the house.

5.2.46 Whether as a direct consequence of the increased power demand of the new powerlooms, or whether just as a result of age, a new boiler was required by 1843. This was again acquired from Boulton and Watt (Figs 39, and 40), and was housed in a new structure placed to the west of the new 1835 engine house, to the north of the scutching room Mill (Fig 173: 4e). This, like the basement of the second weaving block, was of fireproof, brick-vaulted construction below a flat roof, typical of a small boiler house of the period, and was erected to house a wagon boiler. What was somewhat unusual was how the boiler was charged, as the boiler was placed with its front adjacent to the river. The Boulton and Watt plans clearly show that access to the charging platform was from a doorway at the western end of the north wall, remodelled latterly to a window (Plate 87).

5.2.47 Although the documentary sources date both to 1843, the structure to the south of the 1843 boiler house was stratigraphically a later build, and replaced the scutching room with a two-storey, eight-bay preparation block, comprising a ground-floor blowing room, below a mixing room on the upper floor Mill (Fig 173: 4f). This was again of fireproof brick-arch construction, presumably given the combustible processes occurring in the blowing room, with brick vaulting to both floors below a flat roof. A somewhat unusual narrow spiral internal stair between the two floors was included, but projected from the east wall, maximising the floor space within the structure. Given the wider 8.35m width of the structure, the iron ceiling beams were jointed around 5” diameter cast-iron columns, which were socketed vertically, representing the first use of this method of construction at Quarry Bank Mill, typical of brick-vaulted structures of the period (Giles and Goodall 1992). The blowing room had a series of underfloor flues (Figs 33-38), and there is no reason to suspect that these do not survive beneath the extant concrete and sandstone flag floor.

5.2.48 The output of the steam engine was increased in 1853, when it was McNaughted by the Manchester engineers Peel and Williams (QBM Memoranda, 69). This involved the addition of a second cylinder, and was accompanied by the installation of a second boiler to provide the necessary increase in steam pressure. This was placed within a new structure, to the east of the engine Mill (Fig 173: 4g), with the boiler housed between two sandstone block walls which clearly predated this extension to the power plant. The raking face of both walls suggests that they formed structural buttressing, almost certainly as part of earlier retaining walls.

5.2.49 Excavations undertaken in 1993-4 did not reveal any evidence to suggest that the aperture atop the southern wall related to the power-transmission system (Milln 1994, 14), suggesting that it was an unrelated feature, relating to the earlier use of the area. The bed of the 1836 engine was placed directly onto the natural sandstone bedrock, within a '*deeply excavated foundation*' (*op cit*, 12), and it is possible that the retaining walls to the east of this engine house related to access from the road to the east, for the construction of the engine bed and installation of the engine. A plan of 1844 appears to show the southern of the retaining walls (Fig 41), with a return around the stair tower, which was recessed below the road level to the east.

5.2.50 The structure above was built of brick, and was of two-storey height, affording access above the boiler. Although a butt joint between the boiler house and earlier engine house is clearly visible in the north wall, the king post roof truss is continuous, suggesting that the entire structure was re-roofed at this time. The routing of the flue from this boiler to the chimney is unclear, but an aperture in the north bay (OMLG1) of the west wall of the Old Mill may well represent its entry into the earlier flue from the original boiler.

5.2.51 It was also during this phase that the high-level gantries between the main building ranges of the complex were introduced. These allowed easier flow of materials above the thoroughfares below, and reduced the use of hoists. The first was constructed between the warehouse to the north of the stables, and the southern weaving block in 1855. This was not linked to the Greg Rooms until a third storey was added in 1885. A further gangway was shown on the 1855 plan, between the upper floor of the weaving block and the hoist tower against the south wall of New Mill, which was itself refurbished in 1845. This gangway was replaced in 1879 (*Section 3.6.10*), and the similarity between the two structures suggests that both have been refurbished subsequently.

5.2.52 ***Phase 5 – Investment under Edward Hyde Greg (1870-1900):*** the alterations of the following phase relate mainly to the continued improvement of the steam-power plant and internal machinery, with some structural additions to the southern part of the eastern range of buildings. This coincides with the change of control of the operation of the mill to Edward Hyde Greg, on the retirement of his father in 1870 (*Section 3.7.1*).

5.2.53 Whilst no physical evidence for the replacement of throstles or mules survives, evidence can be inferred indirectly by the increasing demand for power from the steam engine. The first of these comprised the installation of a new 60hp horizontal engine into the 1843 boiler house. Although this was removed subsequently, and recently replaced with a museum exhibit engine, its inserted sandstone block engine bed survives, together with an axle bearing and additional bearing boxes for two apparent phases of drive shaft, which transferred power from a pinion wheel through the blowing room and into the weaving sheds to the south. The footstep bearing for a vertical drive in the northern of the two sheds survives adjacent to the north wall, demonstrating the position of an upright shaft that translated power to the upper floor of the north shed.

5.2.54 The 1853 wagon boiler was unable to generate enough working pressure for the new engine, so a new boiler was also required. Quarry Bank Mill did not have quite the same problem as many mills did, in the need to complete a new power plant before disconnecting the old one so as to minimise the impact on production, as the New Mill water wheel was still providing approximately 100hp when water levels permitted. However, with both the 1836 engine and 1853 boiler being retained, a similar problem of finding a new space to house the new 28' Cornish boiler was presented. The site was bounded by thoroughfares on three sides, and the river to the west, with no apparent possibility of construction to the west of the river. The reluctance to use this space again appears to highlight an instance of the conflict between business and estate for the Gregs. Instead, the new boiler was placed in a boiler house cut into the bedrock beneath the road on the eastern side of the complex, to the south of the existing boiler (Fig 173: 5a). This was clearly a significant undertaking, but did have the advantage that the rear of the boiler, at the western end, was easily connected into the flue from the 1853 boiler. Also, being lower than the road allowed for the easy loading of the charging platform with coal. Although the majority of the boiler house was subterranean, what was effectively a 'fake' boiler house was constructed adjacent to the road, with a pitched roof above a central doorway, and provided access to the charging platform below, presumably via a ladder. The design of the structure, which appears relatively typical, if shorter than a standard boiler house of the period, presumably reflects a desire to conform to standards. However, this may simply reflect that it was simpler to build what was essentially an entrance, as a boiler house, rather than design a separate structure. Although the boiler was removed subsequently, and the site now houses a modern gas boiler, the flues at the rear of the boiler survive relatively intact, and retain elements of the dampers.

5.2.55 The chimney soon proved to be inadequate for efficient use with two boilers, and thus a new chimney was installed in an ideal position at the rear of the boiler house (Fig 173: 5b), in the re-entrant angle between the stair tower of the Old Mill and its gable. Its tapering brick design was typical of the period and its octagonal section became relatively fashionable in the region in the mid-nineteenth century (Williams with Farnie 1992, 87), with almost all late nineteenth-century mills in south Lancashire having similar chimneys, without the square plinths of the earliest examples by the end of the century (*op cit*, 113).

5.2.56 Chimneys were generally placed to the rear of the mill, as with the original chimney of the early nineteenth century, but the positioning of the 1875 chimney to the rear of Quarry Bank Mill would have been uneconomical. Its decorative design was more suited to its placement on the front façade of the mill, and was relatively cheaply constructed, with a simple sandstone oversailing cap providing the only additional ornamentation. Chimneys elsewhere became significant architectural features in their own right around this date, with fine decorative examples particularly being prevalent in West Yorkshire; the Italianate example of 1871 at Manningham Mills in Bradford, being one of the more elaborate examples (Giles and Goodall 1992, 153).

5.2.57 The original chimney was retained, and may have served the 1853 boiler until its removal in 1880, with the chimney finally being reduced to the level of the Old Mill in 1885 (*Section 3.7.7*). The new boiler of 1880 represents the last of the steam boilers bought for Quarry Bank Mill, and was manufactured locally by Thomas Oldham in Stockport, to the same dimensions as that built in 1871 (*Section 3.7.12*). This boiler survives extant, although not in its original position (*Section 5.6.6*), and represents a well-restored example of a mid-nineteenth century Cornish boiler. More efficient, and potentially larger, Lancashire boilers were readily available by this date, and even when the earlier boiler was installed in 1871. However, it appears that the older technology of Cornish boilers was deemed adequate for what may still have been regarded as supplementary power at Quarry Bank. The boiler house formed a simple extension to the earlier structure, with an external access to the upper level in the north wall, giving access to a brick-arched tunnel beneath the road, and over the top of the boiler (Fig 173: 5d). A doorway was provided at the lower level between the two boiler houses, but the angled slope of the bedrock to the east of the road suggests that the charging platform was primarily accessed from the eastern side of the road, as with the earlier boiler. The structure above road level on the eastern side was less typical of a boiler house, unlike the earlier building, and comprised a simple, plain, brick façade, giving the appearance of a walled garden, and was possibly deemed more suitable, given its proximity to the mill owner's residence.

5.2.58 In a fairly remarkable contrast, the cost-efficiency of the steam-power plant became of great importance within a decade, when it was decided to install a Green's economiser to reduce the use of fuel within the plant (*Section 3.7.14*). These were first patented by the Wakefield engineer in 1845, and were being used widely across the region during this phase at Quarry Bank Mill (Williams with Farnie 1992, 87). One could easily have been incorporated into the design of either the 1871 or 1880 boiler houses, but the absence of an economiser probably reflects that steam power, even at these late dates, was intended to be supplementary to water power. The acceptance of the need for an economiser was not realised until significantly later, leading to a remodelling of the 1880 boiler house. Although the economiser itself has been removed, and nothing apparently survives of its footprint, its main and bypass flues, in the south wall of the 1853 boiler house, survive, and were lined with refractory brick.

5.2.59 The other evidence for its insertion was the relocation of the Cornish boiler, approximately 20' to the east, to its present location. This required the excavation of bedrock to the east of the extant boiler house, and presumably the creation of a platform above the eastern end of the boiler, allowing coal to be delivered to a new vertical chute, cut into the bedrock in the north-eastern corner of the new structure. This is possibly a unique boiler house feature, and still retains some of its timber shuttering, which afforded protection to the boilermen below whilst the chute was in operation. At charging-platform level, the bedrock was excavated beyond the level of the wall above, to create a storage area for coal for the boiler. Again, this is probably a unique feature, and was gently curved to allow for its more ergonomic use.

5.2.60 Remodelling of the structures to the south of the New Mill was also undertaken during this phase. The first of these comprised the construction of the two-storey office block at the southern end of the range in 1876-7 (*Section 3.7.10*) Mill (Fig 173: 5c). Although relatively plain externally, and incorporating a store at its lower level, the upper floor had a hipped lead roof with rolled ridges, and was more elegant internally, forming a private office behind the general office and counting house.

5.2.61 A decade later, an upper floor was added to the counting house for warp sizing. This comprised a single open-plan room, with braced king post trusses, and with the tie beams bearing no evidence for a loft above. Although seemingly a relatively minor enlargement, this allowed the process to be moved from company premises in Bollington (*Section 3.7.15*).

5.2.62 In 1894, the weaving block of 1839 was repaired, with the insertion of columns at ground-floor level, and associated steelwork supporting the timber beams. Three external piers on the external wall face give the appearance of early heating towers, but, given the documentary evidence for the repair of the front wall (*Section 3.7.17*), these appear to form brick piers forming part of the stabilisation of the elevation.

5.2.63 During the latter part of the nineteenth century, several means of enclosing the northern end of the courtyard between the Old Mill and the 1843 preparation block were undertaken. This involved the blocking of windows within the preparation block, observed at both levels, although the majority of other structural elements, including a glass roof of 1895 (*Section 3.7.18*), were remodelled during restoration of the complex.

5.2.64 Even following the large structural changes within this phase, Quarry Bank Mill was now a small mill, compared with the large integrated complexes appearing within the region in the final decades of the nineteenth century, and certainly into the first two decades of the twentieth century, with the erection of the enormous brick-built Edwardian mills, mainly in the satellite towns around Manchester, most notably Oldham and Bolton. It is possibly only through the continual ownership by a single, relatively powerful family, with so much invested into the concern, and the lack of alternative employment for the isolated workforce, that a small, inefficient mill, which had not specialised, as many complexes in similar circumstances had done, was able to survive into the twentieth century at all.

5.2.63 ***Phase 6 – Twentieth Century Expansion and Decline (1900-59):*** the twentieth century saw a continued change in the focus of the company from spinning to weaving, with the introduction of Northrop looms in 1909. This probably reflects the comparatively small scale of operation at Quarry Bank Mill when compared to new, larger and more efficient mills, coupled with a trend for specialisation in a particular branch of the textile-manufacturing industry that had become firmly established by the end of the nineteenth century. No evidence for this shift to specialised weaving survives within the current fabric at Quarry Bank Mill, with the only physical evidence for the major alterations of the phase being the insertion in 1904 of a pair of water turbines into the 1796 wheel pit (Fig 173: 6). The turbines survive *in situ*, although the associated overhaul of the internal power system not only removed all elements of the original shafting, but was itself removed subsequently, leaving little physical evidence for any of the internal arrangement of power supply within the complex. The new transmission system was based on steel rope drives, rather than iron line shafts and associated heavy gears. Plans for the position of the drives survive (Figs 50 and 51), with the smaller turbine driving ropes in the preparation and weaving blocks.

5.2.64 No further major structural development was undertaken within this part of the complex prior to its closure. However, a series of small-scale repairs, and minor modifications were scrupulously recorded within the mill memoranda (*Section 3.8*), the majority of which can still be identified in the extant fabric.

5.3 CONCLUSIONS

5.3.1 ***Introduction:*** the building survey, in conjunction with the detailed documentary study, has provided an opportunity to obtain a comprehensive insight into the construction and development of one of the most significant textile mills in north-west England, and has refined the current understanding of the mill complex. The mill has been subject to considerable expansion, and there have been numerous changes to the power system, incorporating increasingly larger water wheels, and the establishment of auxiliary steam engines. There have also been a significant change of use from spinning to weaving that initially prompted the construction of bespoke weaving blocks, but ultimately entailed the conversion of the older mill buildings to weaving. Amidst all these considerable developments extending over 230 years, however, it is perhaps inevitable that some of the remains of the earlier mill constructions have been lost or obscured by later changes, although these modernisations themselves insured the survival of the complex as a whole.

5.3.2 ***The Gregs:*** the development and progress of Quarry Bank Mill was due entirely to the vision and entrepreneurial skill of the Greg family. Originating from a wealthy family with strong connections to textile manufacturing in eighteenth-century Lancashire, Samuel Greg was well placed to capitalise on the opportunities presented by the emergence of the factory-based cotton industry in the 1770s. Samuel was one of numerous entrepreneurs responsible for the initial development of cotton mills in north-west England in the last quarter of the eighteenth century, but was amongst a select few that managed to weather the severe economic fluctuations that characterised the trade during the 1790s and led to the bankruptcy of numerous pioneering manufacturers.

5.3.3 In common with most of the early factory enterprises, the initial success of Quarry Bank Mill was dependent upon a partnership between substantial capital, provided by Samuel Greg, and technical expertise in the engineering aspects of cotton spinning. This latter ingredient was provided initially by John Massey, and latterly by Peter Ewart. Greg was particularly fortunate in securing a partnership with Peter Ewart, who will undoubtedly have contributed significantly to the success of the mill, and was probably instrumental in the adoption of spinning mules Quarry Bank, enabling Greg to enter the lucrative market for fine yarn.

5.3.4 The period of expansion at Quarry Bank Mill after 1817 was coupled with the significant growth of Greg's business, which included the purchase of other cotton mills in Caton, Lancaster and Bury. The mills on Moor Lane in Lancaster were of particular importance to the family business, and were the company's largest premises during this period. The Greg's position at the forefront of the industry at this time is reflected in the use of Thomas Hewes' suspension wheel that provided the power for the New Mill in 1817-8, and is probably one of the earliest examples of their use in the country. In other respects, however, some aspects of the engineering employed in the construction of the New Mill was not the most advanced technology. The layout and character of the columns employed in the mill, for instance, was a little behind the times in terms of structural development.

5.3.5 The documentary evidence indicates that whilst Samuel Greg had installed a few looms at Quarry Bank Mill in the early nineteenth century, his early attempts at running a combined spinning and weaving factory were focused at Moor Lane Mill in Lancaster, which provided an early example of a fully integrated cotton mill. This was supplemented in 1827 when Samuel Greg purchased Hudcar Mill in Bury, another integrated mill and, in 1832, he also secured the lease of Lowerhouse Mill in Bollington, which he operated as a combined spinning and weaving factory (*Section 3.1.6 above*). In the light of the success of these integrated mills, it is perhaps surprising that it was Robert Hyde Greg rather than his father that capitalised upon the economic advantages of the powerloom by installing these new machines in purpose-built structures at Quarry Bank Mill. Indeed, the development of Quarry Bank Mill as a combined spinning and weaving factory not only lagged behind the firm's other mills, but also other mills in the region, and may have been necessitated by the declining profitability of a dependency on spinning.

Plate 136: Portrait of Samuel Greg dating to c 1820

5.3.6 Robert Hyde Greg made other important contributions to the family business in addition to introducing powerloom weaving to Quarry Bank. In particular, he was responsible for establishing the Victoria Mill and Albert Mill in Reddish after 1845, which proved to be enormously successful. In contrast, the fortunes of the family business declined during the last quarter of the nineteenth century under Edward Hyde Greg. This was probably due to the evolving geographical specialisation of the branches of the cotton industry, rather than a reflection of Edward Hyde Greg business acumen, with the growth of Oldham as the premier centre for spinning and north-east Lancashire as the 'weaving capital of the world'.

5.3.7 The relatively remote location of Quarry Bank Mill, with its lack of access to the region's expanding railway network, will have been a significant disadvantage during this period. Edward Hyde Greg's choice to install ring-

spinning machines during the 1880s was presumably a vain attempt to retain the competitiveness of Quarry Bank Mill, although the decision to close the spinning departments in the 1890s is perhaps unsurprising. Indeed, given the geographic location of Quarry Bank, it is perhaps remarkable that the Greg's managed to continue spinning as late as the 1890s.

5.3.8 The management of Quarry Bank Mill passed to Robert Alexander Greg in 1900, who installed Northrop looms in 1909. These improved looms were invented in America in 1895, and began to be manufactured in Britain in 1902. Quarry Bank Mill was thus amongst the first wave of textile mills in the region to adopt these new looms.

5.3.9 ***Avenues for Future Research:*** the present project represents the most comprehensive archaeological study that has ever been undertaken of this immensely important textile mill, not least as it has enabled all previous research and investigation to be synthesised into a single volume. Indeed, only a small number of former textile mills in the country have been subject to a similar level of research. This reflects to some degree the remarkable and unprecedented extent and depth of the available archival material for Quarry Bank Mill. Notwithstanding this rich documentary source, and the detailed record of the physical structures generated from the present survey, it is perhaps inevitable that some research questions of the development of the mill complex remain unanswered, offering avenues for future research should the appropriate opportunities arise.

5.3.10 The extensive use of fireproof sheeting and heavy painting has not made it possible to establish the timber used within the construction of the earlier elements of Quarry Bank Mill, and specialist timber sampling in the future would prove useful. Whilst documentary sources refer to the purchase of oak planks for the construction of the mill as early as 1783, confirmation of the type of timber employed in the fabric of original mill would be of academic interest.

5.3.11 The documentary sources indicate that the Old Mill was raised in height by a floor in 1796, at the same time that the extension was added (*Section 3.4.1*). However, there is little evidence within the extant fabric for this raising of the building. The trusses of the Old Mill and the extension are different, so a new roof was not simply added across the enlarged building once the walls had been constructed. Without removing the flooring of the upper floor, it is not possible to establish whether the trusses were hoisted up to the new roof level, which is the more likely option, or whether the original tie beams of trusses to each bay, were left to form ceiling beams of the penultimate floor, and new tie beam were added to house a reduced number of rebuilt trusses above. If there needs to be any maintenance or repair to the upper floor then the opportunity should be taken to have an archaeological watching brief during the process and thereby enable a better understanding of how the Old Mill was raised.

5.3.12 Excavation in 1995-6 recorded possible drains set into the backfill of the northern internal wheelpit. Given the documented use of this area of the mill in the 1820s and 1830s, these may in fact have been flues for the blowing machines in use here at that time. Confirmation of this suggestion provides a further opportunity for future research.

5.3.13 There has been considerable debate and assessment of a substantial stone structure within the southern side of the 1853 boiler house, which has the appearance of an axle mount (*Section 5.2.9*). The overall conclusion is that it was probably not an axle mount for a wheel, but no alternative explanation has been offered. The other side of the southern wall of the boiler house is presently concealed, and may be a void for which there is presently no access or, less likely, a solid block of masonry. Either way an understanding of what is on the southern side of the wall is key to understanding the function of the stone structure. Should access be obtained to this area / void in the event of any future repair or reconstruction works then it is important that it be subject to archaeological analysis.

5.3.14 It had been hoped to obtain detailed information relating to the later twentieth-century history of the mill as part of the present study, and in particular plans of late twentieth century alterations to the mill. However, in the event this information has not been forthcoming. It is therefore recommended that the National Trust explores its archives to identify and collate all information documenting the late twentieth century and the management of the mill after 1976 by the Quarry Bank Mill Trust Limited and after 2004 by the National Trust.

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APPENDIX 1: GLOSSARY

BUILDING TERMS

Bay	The portion of a structure between principal supporting beams, also used as a relative length of measurement.
Coping	Protective course of masonry or brickwork capping a wall.
Cornice	A flat-topped ledge with moulded underside projecting along the top of a building, or the decorative moulding in the angle between wall and ceiling.
English Garden Wall bond	A pattern of bonding bricks that uses more than one course of stretchers between two courses of headers. The ratio is usually three or five courses of stretchers, but other combinations exist. It is one of the most popular of all brickwork bonds, particularly in the north of England.
Flemish Bond	A pattern of bonding bricks whereby headers and stretchers are used alternately in each course.
Half-truss	One half of a full truss, set longitudinally to support a hipped roof.
Header	A brick laid across the wall thickness to expose an end face.
Hipped Roof	A ridged roof with sloping faces to each end, as opposed to vertical gables.
Queen post	Transverse frames supporting the roof at each bay division, formed of pairs of vertical struts between tie beam and collar, supporting only the principal rafters, not longitudinal timbers
Quoin	Shaped stone used to form the corners of walls or door and window openings.
Purlin	A longitudinal member supporting the common rafters of a roof.
Ridge board	A light plank used to support the upper ends of common rafters at the apex of a roof. Often clasped by a truss.
Scantlings	A measured or prescribed size, dimensions, or calibre. Generally used to describe the cross-section of a timber.
Soffits	A term usually applied to the under horizontal face of an architrave or horizontal cornice, but also used to describe the under surface of a beam, lintel, vault or arch.
Stretcher	A brick laid longitudinally within a wall, exposing one long face.
Voussoir	A wedge-shaped stone block or brick which forms part of an arch.

TEXTILE TERMS

Bobbin	A round spool for holding yarn, frequently flanged at both ends.
Calico	White cotton cloth with patterns printed in one or more colours.
Card	A fine but stiff wire brush by means of which fibrous materials may be disentangled preparatory to spinning. The term is also used to mean a carding engine, which combed the fibres mechanically into lengths and laid parallel to form a sliver.
Cloth	Any woven or felted fabric.
Counts	The number of hanks of finished yarn, each 840 yards long, that can be made from one pound of cotton. The higher the count, the finer the thread.
Drawing	Cotton drawn-out and doubled in a drawing frame to straighten the fibres and even out the grist.
Economiser	A devise used to increase the steam-raisinghttp://en.wikipedia.org/wiki/Thermal_efficiency of the boilers of stationary steam engines. It consisted of an array of vertical cast-iron tubes connected to a tank of water above and below, between which the boiler's exhaust gases passed. This pre-heated the feed water to the boiler, thereby saving the amount of coal used.
Fustian	Strong twilled cloth, with a linen warp and a cotton weft, whose production increased steadily in the Manchester area during the early seventeenth century.
Hank	Unit of length. In reference to cotton yarn, one hank equates to 840 yards.
Linen	Cloth made of flax yarn.
Mule	Cotton-spinning machine derived from an invention by Samuel Crompton, and so-named because it combined the roller-drawing principle of Arkwright's water-frame and the carriage-drawing of Hargreaves' spinning jenny.
Muslin	A class of goods the sole distinguishing feature of which is lightness and openness of texture.
Piecer	Operative employed by a mule spinner to tie together strands of cotton which broke whist spinning. This job was usually undertaken by children.
Ring frame	A continuous spinning machine which largely displaced mules during the twentieth century.
Roving	A thin rope of lightly-twisted, substantially parallel fibres from which yarn is spun. Produced on a roving frame.
Scutcher	A machine for opening and cleaning raw cotton, reputedly introduced to Manchester by John Kennedy in 1808-9.
Self-acting mule	The mule spinning frame which automatically performed drawing, twisting, winding-on, and copping motions. The machine was perfected by Richard Roberts in 1830, but was not applied to fine spinning until the 1860s.
Size Mixing	Size is a glutinous liquid, into which the spun yarn is immersed prior to weaving and gives the yarn addition strength. The process of making up the size is size mixing.

Throstle	A spinning machine for cotton, wool, and other fibers, differing from a mule in having a continuous action, the processes of drawing, twisting, and winding being carried out simultaneously.
Twist	Yarn intended for use as warp.
Warp	Yarn which lies lengthwise in the cloth.
Water frame	A continuous spinning machine combining the twisting principle of the Saxony wheel with roller draft.
Weaving	Method of making fabric by interlacing threads. Plain weave is a simple, over-under construction giving a flat, even texture, while patterned weaves such as twill and herringbone are obtained by differential raising of warp threads on the loom.
Weft	Yarn intended for the shuttle of a loom, and lies cross-wise in the cloth and combines with the warp.
Yarn	Spun thread.

APPENDIX 2: HISTORICAL BACKGROUND TABLES

5 March 1796	'*Ale to Men Working in Cutt*'	3s 6d
26 March	*'Ale to Men Wor[kin]g in Cutt 2 weeks'*	8s 3d
2 April	'*Men Working at Tunell'*	11s 6d
	'*Ale to D^{o}*'	3s 8d
4 June	'*Ale to Men at Water Wheel*'	4s 8d
11 June	'*Ale to Men finishing New Engine*'	10s 6d
2 July 1796	'*Ale to Men Putting up Shaft 2 Nights*'	6s 6d
	'*Pool finishing New Wheels*'	1s 0d

Table 1: Payments in a cash book for Quarry Bank Mill recording alterations to the power system in 1796 (MA C5/1/2/2)

	Area, sq yds	**Valuation**
Large factory	430	£2580
Engine house	176	£281 12s
Warehouse	96	£336
Cottages	157	£408
Workshops	59	£118
Stables	194	£388
		£4111 12s
Hall end of Mr. Greg's house	183	£960 15s
Kitchen end do	94	£211 10s
		£1172 5s
Overlooker's House	30	£90
Apprentice House	212	£583
Fences, Outhouses, etc.		£145
Weir, Dam Sluices, Shuttles, Culvert, Water Wheels, Wall, Fences etc		£2500

Table 2: Components of Quarry Bank Mill listed in rating assessment, 5 October 1810 (QBM Memoranda, 32)

1819-21 (MA C5/3/1)	**1831 Valuation** (MA C5/1/1/3)	**1834 Valuation** (MA C5/1/1/4)
Card Room 1 *Card Room 2* *Card Room 3* *Card Room 4* *1st Spinning Room* *2nd Spinning Room* *3rd Spinning Room* *4th Spinning Room* *Warping & reeling & winding* *Making Up Room* *New Wheel & Tunnel* *Counting House*	*Scutching room* *Bottom room (carding)* *4th Card Room* *Mechanic's Shop* *Wood Turner's Shop* *Blacksmith's Shop* *Joiner's Shop* *Making up Room* *Shoe maker's shop* *Cotton Warehouse & Cellar* *Counting House* *Painter's Shop*	*Blowing Room* *Mechanics Shop* *Smithy* *Joiners Shop* *Paint Shop* *Turners Shop* *Making-up Room* *Mixing Room* *Store Room* *Waste Picking Room* *Old Machine Room* *Lodge* *Bottom Card Room* *Bottom Spinning Room* *Farther Lodge* *2nd Spinning Room* *5th Spinning Room* *Counting House* *No 2 Card Room* *3rd Spinning Room* *4th Spinning Room* *No 3 Card Room* *Small Reeling Room* *Roller Coverers Rooms* *Reeling Room* *Warping Room* *Store Room on Landing* *Wheel Hole*

Table 3: Rooms in Quarry Bank Mill listed in mill ledger in 1819-21 and valuations in 1831 and 1834

	Floor Area, sq yds	Valuation
Steam pipes & Boiler		£200
Water Wheel & Mill Gearing		£2400
Water Power		£6000
Water Wheel foundation		£1000
New Mill	1889	£1983
Old Mill	2404	£1202
Boiler House &c	288	£288
Making up Room &c	307	£230
Cotton Wharehouse	186	£186
Turner's Shops &c	346	£259
42 Cottages		£3360
Manager's House		£350
Apprentice's House		£500

Table 4: Main components of Quarry Bank Mill listed in 1831 valuation (MA C5/1/1/3)

	Floor Area, sq yds
Boiler House 2 stories	$41^{2}/_{9}$
Engine House 1 story	$41^{8}/_{9}$
1 Boiler House 1 story	$41^{2}/_{9}$
Chimney and Firing place	-
Old mill 5 stories & attic	}481
" Staircase "	}
" Hoist for laps "	}
" 2 Necessaries "	}
New Mill 5 stories & attic	$326^{4}/_{9}$
" Staircase 6 stories	15
" Necessaries "	$3^{4}/_{9}$
" Hoist of Wood& Sheet Iron 6 stories	-
Lodge 2 stories	$15^{2}/_{9}$
Shed for Hot Water 1 story	$12^{7}/_{9}$
Mechanics Shop 2 stories	$90^{3}/_{4}$
Smithy & Counting House 2 stories	$82^{1}/_{2}$
Walls & Necessaries at end	-
Weaving Mill 3 stories	387
Weaving Mill 2 stories & loft	$294^{4}/_{9}$
Fireproof Scutching House 2 stories	$284^{3}/_{9}$
Dust House 1 story	17
Managers House 2 stories	10
" 2 stories	66
Middens &c	$18^{5}/_{9}$
Coach House & Stables 2 stories	-
New Warehouse 1 story	$116^{1}/_{9}$
Mansion House 3 stories	198
" 2 stories & cellars	$183^{5}/_{9}$
" 2 stories	24
" 2 stories	$2^{6}/_{9}$
" Outbuildings & Walls	-

Table 5: Buildings at Quarry Bank Mill listed in valuation of May 1855 (JRL EGR14/17/28/83)

Date	Spindleage		Looms	Source
1796	2425			Rose 1986, Table 2.1
1805	3356			Rose 1986, Table 2.1
Sept 1814	4448	1st Room - 2228 2nd Room - 2220		MA C5/3/1
Sept 1818	4732	No 1 Spinning Room - 2128 No 2 Spinning Room - 2604		MA C5/3/1
March 18/23	9600			MA C5/2/2/3
1831	10,846			MA C5/8/16/1
1841	11,820	9692 throstle, 2128 mule	165	MA C5/8/31
1844		5952 throstle, 5784 (*sic*) mule	305	Ground plan of mill (QBM)
May 1845	11,136	5952 throstle, 5184 mule	305	JRL EGR/14/17/23
1850	11,136		305	MA C5/6/5
1855	11,136	5952 throstle, 5184 mule	305	Ground plan of mill (QBM)
1894				
1895			320'old looms'	MA C5/1/2/8
June 1905			487	QBM Memoranda

Table 6: Number of spindles and looms at Quarry Bank Mill

	***c* 1821-2** (MA C5/3/1; QBM Insurance Plan)	**1831-4** (MA C5/1/3 & 4; QBM T11247)	**1844** (QBM Mill Plan)	**1855** (QBM Mill Plan**)**	**1890** (QBM Valuation)	**1910** (QBM Valuation)	**1923** (MA C5/1/5)
Attic			W[ind]ing?	Winding & Reeling		Store Room	
4th Storey	Card Room 4	4th Card Room	Card	No 4: Preparation and Carding	Mule Spinning, Carding	Heald & Reed Store Room & Store for Household Furniture	Heald & Reed Store
3rd Storey	Card Room 3	No 3 Card Room	Mules	No 3: Mules	Mule Spinning	Winding Room, Bobbin & Yarn Store	Winding Room & Store for yarn or bobbins & in skips
2nd Storey	Card Room 2	No 2 Card Room	Mules	No 2: Mules & Preparation	Mule Spinning	Weaving Room	Weaving Room
1st Storey	Card Room 1	Bottom Card Room	Card Room	No 1: Preparation	Carding	Yarn and General Store Room; Northrop Weaving Room	Store Room; Northrop Weaving Room
Cellar	Mechanics shop & cleaning cotton room	Mechanics Shop; Scutching Room	Mechanics Shop and Bale Cotton	Mechanics Shop, Cotton Store	Bale Store	Yarn Store	Yarn Store

Table 7: Use of the Old Mill by floor, c 1821-1923

	1820-2 (MA C5/3/1)	**1834** (MA C5/1/ 4)	**1844** (QBM, Mill Plan)	**1855** (QBM, Mill Plan**)**	**1890** (QBM, Valuation)	**1910** (QBM, Valuation)	**1923** (MA C5/1/5)

Attic			Winding	Mules		General Store Room	
4th Storey	4th Spinning Room	4th Spinning Room	Frames & Drawing	No 4: Preparation	Preparation	Shaft Race, Plumber's Shop & Store Room	Store Room
3rd Storey	3rd Spinning Room	3rd Spinning Room	Throstles	No 1: Throstles	Throstles	Winding & Warping Room	Winding & Warping Room
2nd Storey	2nd Spinning Room	2nd Spinning Room	Throstles	No 1: Throstles	Throstles	Cloth and Yarn Store Room	Northrop Weft Winding Room
1st Storey	1st Spinning Room	Bottom Spinning Room	Thostles & 2 Jackframes	No 1: Throstles	Preparation	Shaft Race and General Store Room; Water Turbine House etc	Turbine Gearing Room; Water Turbine House etc;
	New Wheel	Wheel Hole	Water Wheel	Waterwheel house		Turbine House and Size Steeping Place	

Table 8: Use of the New Mill by floor, c 1821-1923

No	1890	1910	1923
1	Dwellinghouse, occupied by	Dwelling House	Cottage

	Storekeeper		
2	Stables, 1 storey	Stable and Hay Loft over	
2A		Corrugated Iron Roof forming Cart Shed	
3	Oil Store, 1 storey	Gas Meter House & Picker Steeping Place (Oil Store), 1 storey	Picker Steeping & Gas Meter Place
4	Weaving Beaming & Plaiting, 4 storeys	Cellar: Weaving Room 1st Storey: Northrop Weaving Room 2nd Storey: Weaving Room 3rd Storey: Cloth Warehouse and Looming Room	Cellar: Weaving Room 1st Storey: Northrop Weaving Room 2nd Storey: Weaving Room 3rd Storey: Looming Room & Cloth Warehouse
5	Weaving & Store Rooms, 2 storeys	1st Storey: Weaving Room 2nd Storey: Weaving & Winding Room	1st Storey: Weaving Room 2nd Storey: Weaving Room
6	Blowing & Cotton Mixing Rooms, 2 storeys	1st Storey: Weaving Room 2nd Storey: Weaving Room	1st Storey: Weaving Room 2nd Storey: Weaving Room
7	Fireproof Engine House & Store Room, 2 storeys	Horizontal Engine House	Engine Houses
8	Beam Engine House, 1 storey		
9	Boiler & Economiser House, 1 storey	Boiler and Economiser House, 1 storey	Boiler & Economiser House
10	Boiler House, 1 storey	Boiler House	Boiler House
11	Grinding & Bell Rooms, 5 storeys	Cellar 1st Storey: Belt Piecer's Cabin 2nd Storey: Paint Shop	1st Storey: Strap Piecer's Room 2nd Storey: Paint Shop 3rd Storey: Store Room

		3rd Storey: Store Room 4th Storey: Pulley etc, Store Attic: Clock Room	4th Storey: Pulley etc, Store
12	Bale Store, Carding & Mule Spinning, 5 storeys & attic	Cellar: Yarn Store 1st Storey: Yarn and General Store Room; Northrop Weaving Room 2nd Storey: Weaving Room 3rd Storey: Winding Room, Bobbin & Yarn Store 4th Storey: Heald & Reed Store Room & Store for Household Furniture Attic: Store Room	Cellar: Yarn Store 1st Storey: Store Room; Northrop Weaving Room 2nd Storey: Weaving Room 3rd Storey: Winding Room & Store for Yarn on bobbins & in skips 4th Storey: Heald & Reed Store Attic
12A		Overlooker's Cabins, 2 storeys	2nd Storey: Overlookers Cabin
2A 12B		Waste Room & Passage	Waste Shed etc
12B		Entrance to Waste Shed, 1 storey with corrugated iron roof	
12C		Waste Place, 1 storey with glazed roof	
12D		Glazed Roof forming Hot Water Place	Hot Water Place
13	Carding Throstle & Winding Rooms, 5 storeys & attic	Cellar: Turbine House and Size Steeping Place 1st Storey: Shaft Race and General Store Room; Water Turbine House etc 2nd Storey: Cloth and Yarn Store Room 3rd Storey: Winding & Warping Room 4th Storey: Shaft Race, Plumber's Shop & Store Room Attic: General Store Room	1st Storey: Turbine Gearing Room; Water Turbine House etc. 2nd Storey: Northrop Weft Winding Room 3rd Storey: Winding & Warping Room 4th Storey: Store over Winding & Warping Room Attic over Winding & Warping Room

15	Lodge & Store Room, 2 storeys		1st Storey: Strap Piecer's Cabin and Entrance Passage 3rd Storey: Size Mixing Place		1st Storey: Strap Piecers Cabin	
16 & 17	**16**	**17**	**16**	**17**	**16**	**17**
	Ground Floor: Mechanics Shop 1st Floor: Joiners Shop	Ground Floor: Smithy 1st Floor: General Office; Cotton Sample & Waiting Rooms	1st Storey: Mechanics' Shop 2nd Storey: Joiners' Shop	1st Storey: Smithy 2nd Storey: Entrance to Offices; General Office; Back Office	1st Storey: Mechanics' Shop 2nd Storey: Joiners' Shop	st Storey: Smithy nd Storey: Entrance to ffices; General Office; ack Office
	2nd Floor: Slashing Room		3rd Storey: Tape Sizing Room		3rd Storey: Tape Sizing Room	
17A	Size Mixing & Private Office, 2 storeys 1st Floor: Private Office		1st Storey: Provender Room (Hay Chopping Room) 2nd Storey: Private Office		2nd Storey: Private Office	
18	Cloth Warehouse (Bale Store & Loading Place), 1 storey		Cloth Store, 1 storey		Cloth Store	
19	Stables, Coach House & Harness Room, 2 storeys					
20	Coal & Cannel House, 1 storey					
21	Gas Retort & Purifying House, 1 storey		Lurry Shed & Fives Court (Cart Shed)			
	One Set Pan outside no 17 for heating water for Workpeople including Brick setting & Corrugated iron cover					

Table 9: Quarry Bank Mill in valuations of 1890, 1910 and 1923. See also Figures 53 and 55 for location of nos.

ILLUSTRATIONS

VOLUME 2 FIGURES:

VOLUME 3 FIGURES:

PLATES

Plate 26: 20-light window frames

Plate 27: Ground floor general view

Plate 28: Extant lath and plaster ceiling

Plate 29: Late I-section steel flitch plates bracing the western part of the second beam

Plate 30: I-section beams, still present across the 6th, 8th, and 11th bays

Plate 31: Gouged drum scars on the beam faces, indicating position line shaft

Plate 32: Bevelled timber mounting bracket in the southern bay aligned with the upright shaft

Plate 33: Interior of the First Floor, looking north, showing the beam and column arrangement

Plate 34: Open-web rope wheel on the exterior of the northern wall

Plate 35: Twenty light window frame sitting on chamfered stone blocks

Plate 36: Cast iron columns on second floor of Old Mill

Plate 37: King post trusses in the early part of the mill

Plate 38: Scored assembly marks cut into trusses southern faces

Plate 39: Chiselled numerals on trusses southern faces

Plate 40: Queen strut truss with metal sheet cladding forming basic fire proofing

Plate 41: Metal sheet cladding above the plaster lining

Plate 42: Square cast iron frame, possibly used for fire fighting equipment

Plate 43: Fire Proof door leading from New Mill into Old Mill

Plate 44: Interior of the present water wheel

Plate 45: Rim drive gear taking power off the water wheel

Plate 46: Steps leading down to the axle on the north side of the wheel

Plate 47: Doorway from the courtyard providing access to the steps on the north side of the wheel

Plate 48: The blocked arched doorway at the re-entrant angle between Old and New Mills that formerly accessed the wheel chamber

Plate 49: Access to the southern axle was via a timber trap door

Plate 50: A line shaft along the south-west wall, with bevel gear and belt wheel translating power from the floor above

Plate 51: The gable elevation of the New Mill, with mansard roof, has similar windows to those of the Old Mill, with one in each of the seven bays apart from the upper floor which has three

Plate 52: Within north-western corner of the stair tower was a water pipe for fire-fighting

Plate 53: The south wall of the New Mill with privy and hoist towers

Plate 54: Each bay has 20-light timber windows, including tilting top rows

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