University of Salford MANCHESTER

Archaeological Excavation

Chimney and Privy Tower Excavation, Ditherington Flaxmill, Ditherington, Shropshire

Client:
Historic England

Technical Report:
Oliver Cook & Chris Wild

Report No:
SA/2019/79

The Centre for Applied Archaeology

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Location: The site is situated at the north-west side of Spring Gardens (A5191) and north-east of Marshalls Court in Ditherington, Shropshire. The excavation targeted the remains of the chimney and privy tower on the eastern side of the Main Mill.

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Summary

Historic England is leading a scheme of regeneration and development of a former industrial site in the Ditherington area of Shrewsbury (centred on NGR SJ 49888 13849), which was occupied from 1797 by the Ditherington Flax Mill. The flax mill complex is of immense archaeological and historical significance, which is reflected in the designation of several components as Grade I, Grade II* and Grade II listed buildings.

An ongoing building investigation, being undertaken by Salford Archaeology, is providing a valuable opportunity to examine the complex as a whole, documenting physical remains that are being exposed as renovation and conversion of the site progresses. The report, however, presents the results obtained from a detailed examination of two small but intriguing elements of the mill; the privy tower attached to the late eighteenth century Main Mill; and the adjacent boiler-house chimney, situated on the east side of flax mill. The excavation was undertaken in July 2019, and has expanded on the results obtained from an archaeological watching brief carried out by Oxford Archaeology North in 2016, which revealed the remains of the chimney base and several elements of the north boiler house.

The excavation revealed well-preserved remains of the privy tower, chimney, and flues associated with the northern boiler house. These have been ascribed to four main phases of activity, commencing in the late eighteenth century with the construction of the original spinning mill and privy tower. Two large boiler houses and an associated chimney were added to the eastern side of the complex in the 1840s and 1850s, reflecting a technological remodelling of the entire complex, followed by a third phase of remodelling the power plant in the 1870s. The final phase, relating to the use of the complex as a maltings from the late nineteenth century, comprised the replacement of these earlier structures with a single-storey warehouse.

Not only did the excavation reveal the well-preserved remains of the chimney base, confirming an arrangement depicted on detail mid-nineteenth century plans, but also revealed evidence for the insertion of an economiser house in ***c*** 1875, between the boiler houses and the privy tower, and associated remodelling of the flues into the chimney.

Significantly, the excavation provided important evidence relating to other long-standing questions about the origins of the privy tower. The foundation of this structure is of ‘great’ brick construction, dating it to before 1805, and its position, along with differences within the wall footing of the Main Mill to the north and south strongly suggests that it is contemporary with the northern ten bays of the mill, which themselves formed a secondary episode of construction, prior to 1800, following the completion of the southern part of the mil around 1797.

1. Introduction

1.1 Background

In February 2017, Historic England commissioned Salford Archaeology to provide a range of specialist archaeological services to support the second main phase of the Shrewsbury Flax Mill Maltings Project. The principal aim of this flagship rescue project is to restore and conserve a group of 'at risk' buildings on this unique and immensely important industrial heritage site, including the Ditherington Flax Mill, widely acknowledged to be the world's first iron-framed building. Situated in Ditherington on the northern fringe of Shrewsbury (centred on NGR SJ 49888 13849), the flax mill complex is of huge archaeological and historical significance, which is reflected in the designation of several components as Grade I, Grade II* and Grade II listed buildings.

The buildings have been in vacant possession since 1987, and had fallen into a state of dangerous neglect and decay, being considered by Historic England to be one of the most important buildings at risk of neglect and decay in the country. In March 2005, the site was purchased by English Heritage (now Historic England), using a grant provided by Advantage West Midland, with the intention of arresting the gradual decline of the buildings and securing the long-term future of this immensely significant site.

Working in partnership with Shropshire Council and the Friends of the Flaxmill Maltings, English Heritage appointed architects Feilden Clegg Bradley Studios (FCBS) to design a scheme for appropriate development and regeneration of the site, which included a mix of residential, business, community and heritage uses. As part of this process, various elements of archaeological investigation have been carried out since 2009 as part of the Phase 1 Development Works, including an initial desk-based assessment, targeted evaluation trenching, a community-led archaeological excavation, surveys of the malt kiln, stove house and the dye house, photographic surveys of the north and south silos, and archaeological monitoring during the excavation of trial pits that were opened for geotechnical purposes.

The opening of a new Visitor Centre at the site in November 2015 represented the completion of the Phase 1 Development Works, and following the success of trial repairs within the Main Mill, Croft Building Construction were commissioned to undertake the Phase 2 shell repairs within the Main Mill and Malt Kiln, with Salford Archaeology being appointed to provide archaeological monitoring of the works. This work has been ongoing since 2017, and it is anticipated that this stage of the project will be completed in 2021.

The delivery of the repair and restoration project has necessitated some ground-breaking works impacting on buried archaeological remains. Prior to the commencement of any works on site, however, Historic England commissioned Salford Archaeology to formulate an appropriate strategy to mitigate any impact of development on the historic fabric of the buildings and buried archaeological remains. This work has been undertaken as a series of watching briefs, test pits and targetted excavations.

This most recent scheme of works comprised a full examination of two small but intriguing elements of the mill; the Main Mill privy tower; and the adjacent boiler-house chimney. The excavation was situated on the east side of flax mill complex, immediately adjacent to the late eighteenth-century Main Mill (Plate 1; Figure 1). This area saw initial development in the late-eighteenth century but remained largely undeveloped until the creation of two new detached boiler houses in the mid-nineteenth century. These changes were prompted by both the installation of new textile machinery in the mill and improvements to steam plant, which necessitated larger and more efficient boilers. Earlier archaeological test pits undertaken by Oxford Archaeology North in 2016 (OA North 2018) revealed remains of the chimney base, and poorly-preserved elements of the north boiler house.

Plate 1: Recent aerial view across the Main Mill and excavation area

2. Historical Background

2.1 The Flax Mill (1796 – 1886)

Production of linen in Britain took place on a small, subsistence-level, scale from the second half of the seventeenth century through to the last decade of the eighteenth century. Industrial-scale linen production then began, following the lead of the cotton-spinning industry, which had proved that large-scale production could be highly lucrative. One of the key figures in the linen industry was John Marshall, who in 1787 decided to explore the possibility of mechanised flax spinning. Marshall went into partnership with Samuel Fenton, his father's former partner and Ralph Dearlove, a linen manufacturer from Knaresborough. The partners had two businesses in and near Leeds, but parted company in 1793, and Marshall then went into business with Thomas and Benjamin Benyon who lived in Shrewsbury and worked in the wholesale woollen trade (MacLeod ***et al*** 1988, 1-4).

Shrewsbury had traditionally been a finishing and commercial centre for the woollen cloth trade of mid-Wales until the late eighteenth century, when this trade was coming to a close. At this point textile manufacturing was becoming established in Shrewsbury, but it was not until the partnership of Marshall and the Benyons that the area became known for flax manufacture (***op cit***, 4).

Initially, Marshall and the Benyons had a mill in Leeds, but it burnt down in 1796. Although the mill was rebuilt, the partners decided to build another mill in Shrewsbury and brought in Charles Bage to design it. Ditherington Mill was the first wholly iron-framed building, and consequently of 'fireproof' construction. William Strutt of Belper (1756-1830), a friend of Bage's, had previously used iron columns in textile mill buildings. However, Bage advanced this by using iron cross beams, so that brick arches could be sprung from them, and hence removed the need for any structural timber (***op cit***, 5).

There has been suggestion on the basis of fabric evidence that the original mill was built in two stages, the first part to be completed being the southern portion of the Main Mill (six full bays and two short bays) and attached engine house. Upon completion of the first phase, the mill was powered by a 20hp beam engine, supplied by Boulton and Watt (***op cit***, 10). While building work continued textile production within the mill was underway. The proposed second stage of building work saw the completion of the Main Mill (northern ten bays). Although all the processes involved in the production of flax were carried out initially in the Main Mill, within 15 years other buildings had been added to the complex.

The 1988 desk-based assessment looked at the use of 'great' bricks, probably produced at the brickfield to the south-east of the site (SMR 6732), in the construction of the mill buildings as a guide to their date. 'Great' bricks are larger than normal (measuring approximately 100m x 110 x 240mm), so that only three rather than the usual four courses of brick were needed per foot (300mm). This was possibly done to cut down on the amount of brick tax required to be paid, as this was charged per brick (MacLeod ***et al*** 1988, 21).

The flax warehouse which was completed in 1805, is built of standard bricks. The buildings known from documentary sources to be earlier than this are built of 'great' bricks, whilst those known to be later are of standard bricks. Undated buildings can therefore be assigned a date of either before or after 1805 according to this theory. A number of minor buildings with no date available from documentary sources were therefore dated as pre-1805 in the 1988 desk based assessment.

By 1800, a second beam engine had been installed at the north end of the Main Mill. This engine was a 40hp model and, in 1811, a 60hp was installed as a replacement for the original engine. The Cross Building, for hackling or flax dressing, was completed by 1803, and the flax warehouse by 1805. The first dye house was in operation by 1804, with the stove added to it by 1811. The warehouse, later known as the packing shop had been constructed by 1801 and the blacksmith's shop and stables appear to have been built by 1805.

In addition to the mill buildings, various housing for the workers was also constructed. A group of cluster houses was built between the Shrewsbury Canal and the turnpike road in the winter of 1796-7, and another group was constructed subsequently (***op cit***, 11).

By 1811, the Apprentice House had been constructed, with the objective of housing children recruited by various parishes to work in the mill and learn the trade. This Apprentice House appears to have replaced an earlier building, constructed near the mill by the architect John Simpson by 1800. A house for the factory clerk was also designed by Simpson and constructed at this time. The 1988 desk-based assessment of Ditherington Mill suggested that nos 56-59 St Michael's Street, to the south of the former mill, was the original Apprentice House, and no 55 the clerk's house (MacLeod et al 1988, 11).

On October 24th 1811, a devastating fire in the Cross Building caused the roof to collapse, although a fireproof staircase prevented the fire from spreading into the Main Mill (***op cit***, 11-3). A recently installed gas lighting system by Boulton and Watt was wrongly blamed for the fire. Unlike the Main Mill, the Cross Building was not of fireproof construction. A suspension bridge, which linked this building to the flax warehouse allowed some people to escape the burning building, although others died.

Within the first few years of Ditherington Flax Mill being operational, Marshall became unhappy with Bage's involvement in the partnership, and in 1804 he bought out both Bage and the Benyons (***op cit***, 5). Marshall went into partnership subsequently with two of his employees: John Hives, who managed the Leeds business; and William Hutton, who was in charge of Ditherington Mill. In 1815 the management of Ditherington Mill passed to another employee, Joseph Robert Atkinson, although his partnership with Marshall was dissolved in 1825. Marshall maintained control of the mill by retaining ownership of the buildings and the engines, whilst various partners held the machinery and stock and ran operations (***op cit***, 12).

In 1819-20 a 56hp engine replaced the 40hp engine at the north end of the Main Mill, possibly in anticipation of the wet-spinning process, which was introduced to the mill during the 1820s. In 1837, a pumping machine for a well had been provided by Hick of Bolton, and new boilers and a chimney were added to the east of the Main Mill in 1840 and 1852-53. A new gas lighting system, with a retort house on the northern boundary of the site and a round gas holder was established in 1842. In the 1850s, the dye house was enlarged and, in 1875, both engines were replaced by a pair of Corliss engines by Hick of Bolton (***op cit***, 12-14).

The mill produced various types of thread and yarn during the first half of the nineteenth century, and employed some weavers to manufacture canvas, although this activity appears to have ceased in the 1820s. Ancillary to flax spinning, the mill complex housed an engineering shop for manufacturing fluted rollers and other machine parts by 1824, and a printing department, for producing the labels for the thread, was set up in the 1860s (***op cit***, 1 and 13). After his death in 1845, the descendants of John Marshall continued to run the mill successfully until the last quarter of the century, when the business began to decline.

A plan of the site dated 1849 shows only the portion of the mill site including and south of the flax warehouse (Plate 2). The plan is quite detailed, showing internal divisions within the buildings, and the positions of boilers, engines and other features. The gas holder and thread room are shown to the west of the flax warehouse, and to the west of these 'Rack Poles' are marked. Rack poles were structures to enable drying the thread and yarn outside, this took place in this area for a number of years, until the railway sidings were constructed in 1858 (MacLeod ***et al*** 1988, 42). To the south of the dye house and stove, a woodshed is marked, with a saw pit to its south. A well is marked in the yardto its east. Stables, privies, and the office, warehouse and packing shop, are shown along the southern boundary of the site. A lodge and gateway are depicted in the south-east corner of the site, and a weighing machine is marked just inside of this site entrance.

A complete plan of the mill was produced in 1855 (Plate 3), and contains the same level of detail, including internal features, as the 1849 plan. Structures shown in the north-western portion of the site include the round gas holder, the gas retort house, with a coal house in its eastern side, the timber shed, the drying shed, the fire engine house, the gas meter and the waste room. A shed is marked on the east side of the thread room, and the former gas holder, is labelled as a carpenter's shop A saw pit is marked between the carpenter's shop and the thread room. The area previously marked as being used by rack poles is here labelled as 'movable drying stands', and therefore evidently was serving the same purpose. Towards the north-east portion of the site, the Apprentice House is labelled 'Superintendent's House', and a formal garden is shown on its north and east sides. On the northern border of the site are a cow house and stables and a wash house.

Plate 2: Extract from the 1849 plan of the mill

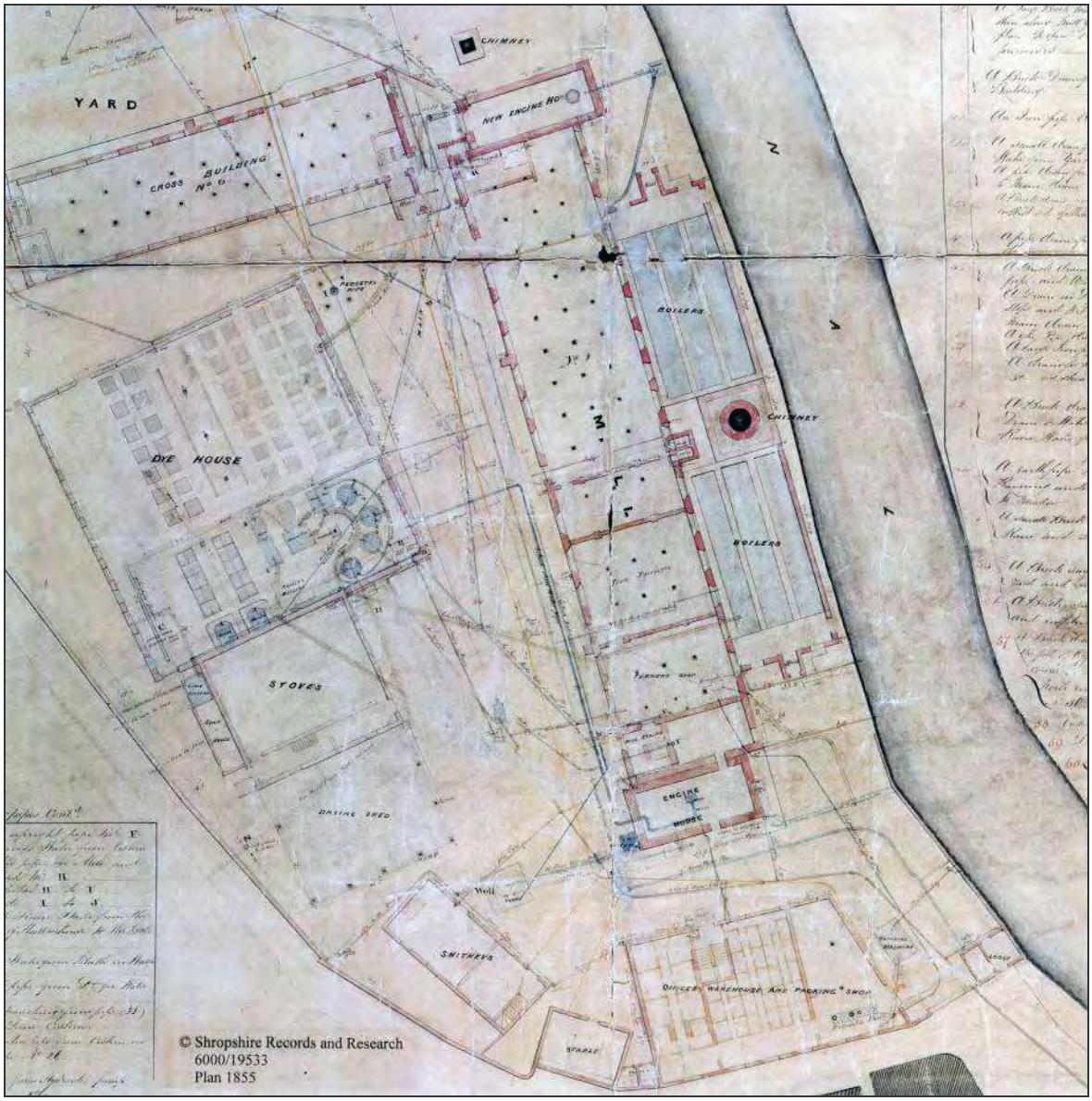

Plate 3: Extract from the 1855 plan of the mill

The 1870s saw the reduction of the range of processes carried out at Ditherington, and the size of the workforce declined as a result. Increasingly, flax was spun at the Leeds mill, and was then transported by rail to Ditherington to be processed into thread and finished by polishing and other processes. The mill employed around 800 people at its peak in the 1840s, but by the 1880s this figure had dropped to around 300. In 1885 the intended closure of the mill, still considered to be the largest firm of flax spinners in the country, was announced, and operations finally wound up in October 1886. It is thought that the mill then stood empty for a decade (***op cit***, 16).

2.2 The Maltings (1887 – 1987)

After being vacant for ten years, the mill was purchased in 1896 by William Jones, who re-named it The Shropshire Maltings. Jones had established a malting business in Shrewsbury in 1869, and acquired several malting premises in the following years, earning himself a reputation for reorganising malting for industrial-scale production. In 1897-8 the Ditherington Mill complex was adapted for malting, which included the addition of the malt kiln at the northern end of the Main Mill. The boilers at the eastern end of the site were removed at this time, and replaced with a single-storey lean-to, thus extending the surface area available for floor malting (***op cit***, 18).

The Main Mill building is labelled 'Malthouses' on the Ordnance Survey second edition 25": 1 mile map of 1902 (Plate 4). The area at the north end of the Main Mill building is shown to have been developed.

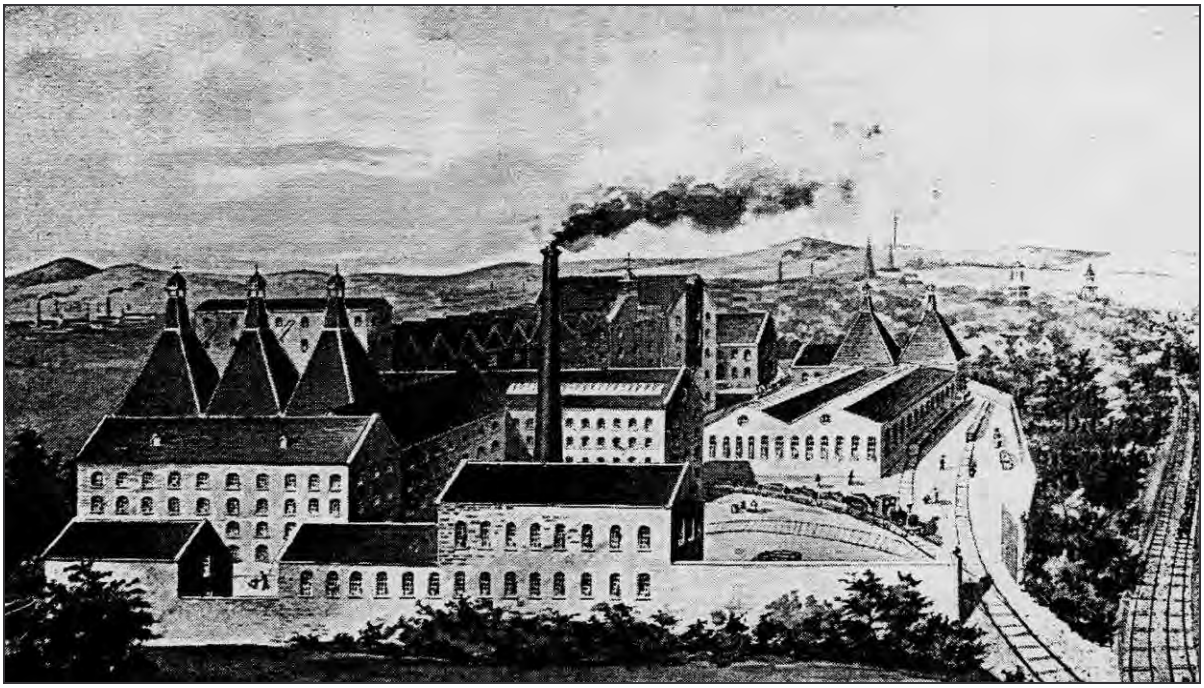

Plate 4: The maltings complex in the late 1800s viewed from the north

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2.3 Previous Archaeological Work

Archaeological monitoring of all groundworks has been undertaken across the complex during both the Phase 1 and Phase 2 works. Of direct relevance to this particular package of works was a series of test pits excavated in 2016, in order to identify the nature of the deposits that would be encountered during drainage work. (OA North 2018).

A rectangular test pit measuring 2.5 x 1.8m was placed to the east of the Main Mill, in the position of a large double boiler house, shown on plans from 1849. The trench was targeted on the central chimney between the two boiler houses, in order to assess levels of preservation to inform the position of drains required by the refurbishment of the mill complex. Excavation revealed substantial, well-preserved remains of the south wall of northern boiler house were revealed, 0.8m below the present concrete ground surface, and surviving to a depth of 1.85m below ground level (Plate 5). The partial floor of a flue of 0.56m width butted its southern side, and formed a surface to the north-west corner of chimney. This had a rounded corner and return into a further flue along its north face, which continued beyond the limit of excavation, where it appeared to have a bull-nosed return to the south, presumably into the base of the chimney. The northern boiler house wall was also of refractory brick with a 30" wide, segmentally-arched aperture at the western side of the trench (Plate 6), presumably into the western boiler bed. This was blocked subsequently with plain with red brick, demonstrating different phases of activity within the power system of the second half of the nineteenth century.

Plate 5: Watching brief trench showing remains of the flue located to the north of the chimney

Plate 6: Blocked aperture within the north wall of the flue leading to the north boiler house

3. Methodology

3.1 Archaeological Excavation

The principal aim of the archaeological excavation was to fully expose and record the remains of the chimney and privy tower situated on the eastern side of the flax mill complex (Figure 2). This was achieved via the excavation of a single open-area trench.

General Methodology: all archaeological work was conducted following the CIfA Standards and Guidance for archaeological field excavation (***Standards and Guidelines for an Archaeological Excavation*** CIfA 2014). Prior to the commencement of any excavation works, the location of the areas targeted for archaeological investigation were laid out accurately with respect to the Ordnance Survey national grid. Service plans were inspected and the area scanned for any live services using a cable avoidance tool. The excavations were regularly scanned as work progressed.

Bulk Excavation: this entailed mechanical excavation using a tracked machine of appropriate power to excavate the overburden, which was undertaken under close archaeological supervision. All material excavated was stockpiled away from the trench in a designated stockpile area to the south of the excavation at a safe distance from the edge of the trench and made safe.

Archaeological Excavation: machine excavation was used to define carefully the extent of any surviving structures, features, and other remains. At this point any surviving structural remains were assessed for stability and any considered unsafe were reduced to foundation level and the trench edges battered to make safe. Remains were cleaned manually to define their extent, nature, form and, where possible, phasing and date. Once the extent of buried archaeological remains was established, key remains were subject to detailed archaeological excavation and recording. Hand excavation was undertaken by trained professional archaeologists. All information identified in the course of the site works was recorded stratigraphically and was accompanied with sufficient pictorial record (plans, sections and photographs) to identify and illustrate individual features

Machines were operated and provided by Croft Ltd, historic building repair specialists, in the role of principal contractor. All relevant licences and permits were checked prior to commencement of working.

Spoil: excavated material (spoil) was removed from the excavations and stockpiled in a designated area. The surface materials namely concrete, and any other large obstructions removed during the excavation, were removed prior to excavation and stored in separate stockpiles and not mixed into the main stockpiles of excavated made ground.

Context Recording: a unique text-number site code was created prior to the commencement of the programme of works. Separate contexts were recorded individually and annotated onto drawings and sketches.

Photographic Archive: a comprehensive photographic archive was produced utilising a high-resolution digital camera. All frames, excluding general contextual views, incorporate a graduated metric scale. Photograph records were maintained on special photograph ***pro-forma*** sheets. All photography was carried out following the latest Historic England guidance (***Digital Image Capture and File Storage: Guidelines for Best Practice*** HE 2015).

Planning: a 'site location plan' indicating the site north and based on the current Ordnance Survey 1:1250 map (reproduced with the permission of the Controller of HMSO) was prepared. This is supplemented by a trench plan which shows the location of the areas investigated in relation to the investigation area and National Grid.

The precise location of all archaeological remains encountered was surveyed by Reflectorless Total Station (REDM) instrument survey with integral datalogging and visualisation. This baseline survey was enhanced with orthographic images produced by unmanned aerial vehicle (UAV) photography, undertaken by an in-house commercially qualified pilot, with the images manipulated using industry-standard software (PhotoPlan). This process generates scaled plans within AutoCAD, which are then digitised to create line drawings showing archaeological and architectural detail. The drawings were generated at an accuracy appropriate to the final output scale. All level information is tied in to Ordnance Datum, taken from either GPS or temporary benchmarks set out using GPS. All plan drawings are geo-referenced based on the Ordnance Survey National Grid.

Finds Policy: all finds were collected and handled following the Chartered Institute for Archaeologists' guidelines (***Standards and Guidance for the Collection, Documentation, Conservation and Research of Archaeological Materials*** CIfA 2014). Unstratified material was not kept unless of exceptional intrinsic interest. Material discarded as a consequence of this policy was described and quantified in the field.

4. Excavation Results

4.1 Introduction

The excavation was located on the eastern side of the Spinning Mill. Historic plans indicate a chimney was constructed here in the 1840s, appearing on plans of the mill dated to 1849 and 1855. The chimney was associated with two boiler houses built at this time. The opening-up of an 8.20 x 8.70m area allowed for the full footprint of the chimney base to be exposed (Plate 7). This also gave the opportunity to examine the below-ground remains of the privy tower, which stood against the eastern wall of the mill.

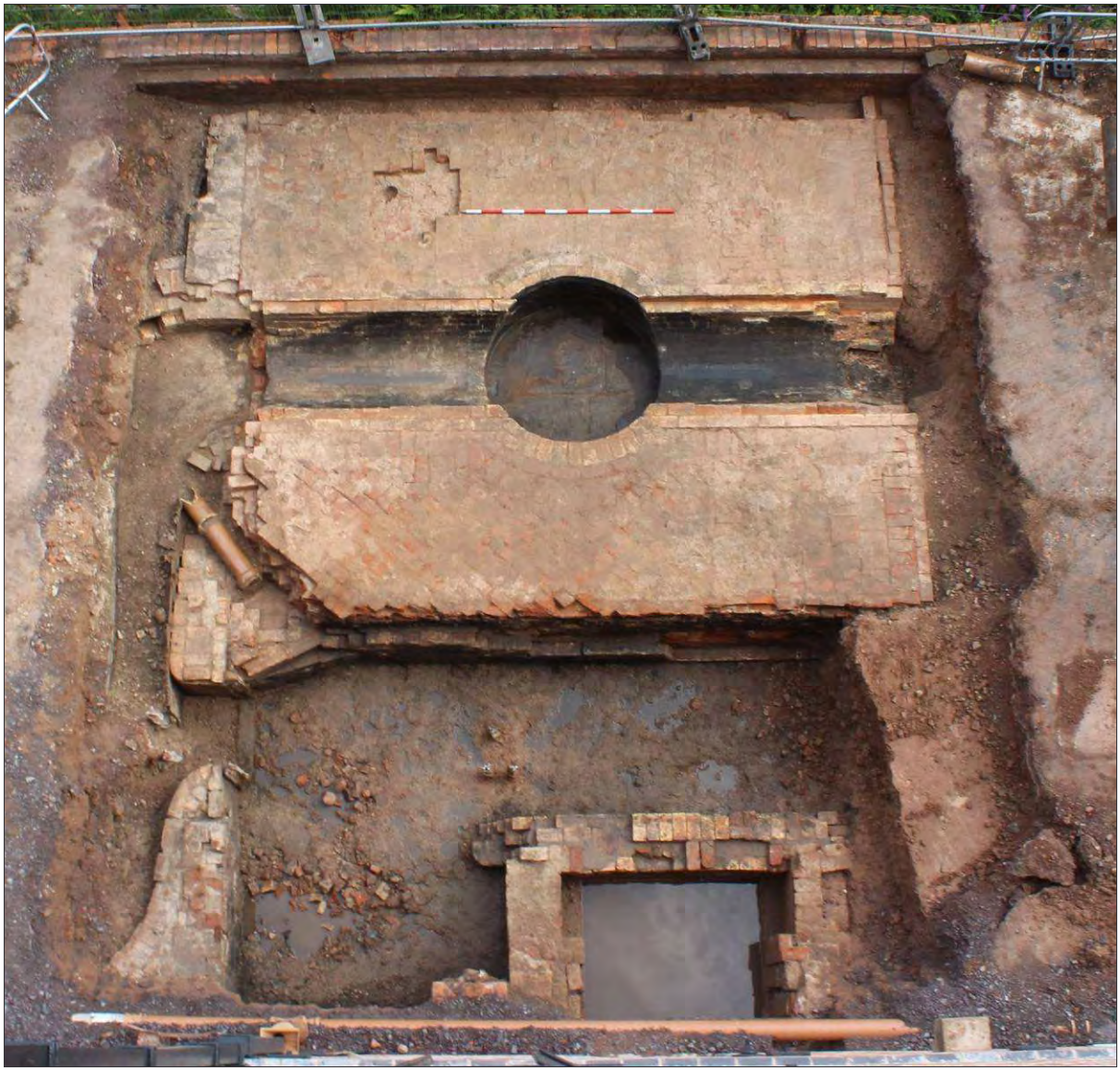

Plate 7: View of excavated remains taken from the top floor of the adjacent Spinning Mill (2m scale)

4.2 The Results

The Privy Tower

The earliest structural remains encountered belong to the privy tower and adjacent Main Mill, located in the south-west corner of the excavation. The tower was a three-sided structure positioned on the eastern side of the mill (Plate 8), measuring approximately 1.50 x 2.88m. Its interior footprint covered an area of 1.27 x 1.95m. The foundations of two walls (***016*** and ***017***) were identified as original components of the tower. The foundations had been subject to several phases of building and adaptation, occurring with updates to the privies, the creation of the adjacent boiler houses and the subsequent conversion and use of the site as a maltings.

Plate 8: General view of the privy tower. Note the soot-staining on wall 018 (2m scale)

The walls of the privy tower (***016*** and ***017***) were aligned north-west/south-east. They had an 'F-shape' in plan, which was formed by two projecting brick piers on the interior sides of the walls, each measuring 0.17 x 0.22m (Plates 9 and 10). The walls measured 1.46m in length and 0.46 in width, widening to 0.63m at the point of the brick piers. The walls survived to a height of between 1.10-1.17m and were placed on stepped stone plinths, each formed of two long, rectangular blocks of stone.

The two parallel stone plinths (each 1.19m long and 0.20m thick) had two visible steps, which were achieved by offset courses of stone revealed at the base of the brick walls (Plate 9). The plinths supported both the main sections of wall and easternmost brick piers. It is noteworthy that the stone plinths were not keyed-in to the Main Mill foundations, stopping short of the structure by approximately 8mm.

Plate 9: The south-western returning pier of wall 017 around which wall 018 had been constructed (0.25m scale)

Plate 10: South-west elevation of wall 016 (1m scale) Note the position of the projecting brick piers and later infill

The fabric of the walls incorporated hand-made brick bonded with hard, light yellowish-white, lime-based mortar. The size of the bricks (224 x 95 x 100mm) are broadly consistent with those of the large 'great' bricks, utilised in the original construction of the Main Mill, suggesting that the privy tower represented a contemporary feature.

On both sides of the privy, the recesses between the mill wall and first brick pier (measuring 0.50 x 0.17m) had been infilled, occurring in two stages. This had been achieved with two crude stacks of reused brick and firebrick with slate packing (Plate 11). The first phase (***022*** and ***024***) butted the mill foundation, and utilised a hard, yellowish-grey lime-based mortar. The second phase of infill (***023*** and ***025***) butted the brick pier, and was bonded with a hard, cement mortar, distinguished from the earlier sandier mortar by its much lighter colour and hardness. The two stacks were in both cases separated by slate packing. The upper extant courses of both privy walls adjoining the mill had been rebuilt using a mixture of bricks, bonded with a cement mortar, and associated with this later episode of infilling (***023*** and ***025***).

Plate 11: Walls 016 after removing the brick infill (022) to reveal the rebated stone block

A section of the infilled brickwork (***022***) in the south-west corner of the structure was carefully removed in order to examine the relationship between the privy tower and the Main Mill at foundation level (Plate 12). This demonstrated that the original fabric of the privy wall clearly continued behind the later brick infilling (***020***) in the Main Mill foundation (Plates 11 and 12), continuing below the upper stone course within the external wall of the mill (Plate 12). Removal of the infill between the pier and the Main Mill also importantly revealed that this course of dressed stonework had a projecting return into the side wall of the privy tower, carved within a single stone block in the exposed southern rebate (Plate12), confirming that the privy tower formed part of the original construction of the Main Mill.

Plate 12: Detail of rebated stone block. Note the tile packing added below the stone.

The eastern wall of the privy tower was significantly remodelled following the construction of a boiler house further to the east in the mid-nineteenth century. This comprised the construction of a new wall, ***018***, measuring 3.16m in length and 0.24m in width, surviving to a maximum height of 0.98m, and projecting 0.28m beyond the north-eastern end of the privy tower footprint. It was truncated in its upper extant part at the southern end, but was observed to continue beyond the limit of excavation to the south in its lower courses.

It was constructed using a mixture of hand-made brick and refractory brick, bonded with a grey, ash-rich mortar, indicative of a late nineteenth-century date. Whilst the northern and southern walls of the privy tower were of two brick thickness, it is unclear whether the remodelled eastern wall represents the addition of a one-brick thick wall to an existing wall of similar thickness, or the refacing of a wall of similar thickness to the side walls, presumably to protect it from the heat of the exhaust gases that were being channelled into this space during the later phase of the boiler house operation. The northward extension beyond the privy tower was faced with bull-nosed bricks around its north-western corner (Plate 13), suggesting that the damaged north-eastern face was also bull-nosed to aid airflow through the chamber (Fig 2).

Plate 13: North-eastern end of wall 017, looking south-west (0.50m scale)

The external face of the wall was heavily stained with soot, demonstrating that hot exhaust gases from the boiler house were passing through the area to the east of the privy tower following the remodelling of the base of the privy tower. The privy tower had been backfilled with a redeposited sandy clay of similar composition to the material overlying the entirety of the structural remains. This was of firm compaction, containing occasional to moderate quantities of demolition debris. This was sealed by the concrete slab floor of the maltings-era building.

To the north and east of the privy tower (between the Main Mill and chimney) the void between the built remains had been infilled first with a loosely compact deposit of demolition debris. This deposit was excavated to a maximum depth of 0.75m and lay below a homogenous deposit of redeposited sandy clay, which covered the entirety of the excavated remains. The water table was encountered 2.0m below present ground level, by which depth any floor surfaces within the base of the privy tower had not been encountered.

The Main Mill Foundation

The foundations of the flax mill were also subject to investigation. The lower part of the east external wall (***019***) was exposed within the western section of the excavation trench revealed several elements of phasing (Plate 14). This comprised a significant wall footing, offset by a substantial 1' (0.30m) distance beyond the face of the wall, at a depth of 0.58m below present ground level. It was of stone and brick construction, the lowest part of which was not visible below the water table and limit of excavation at approximately 2.0m below present ground level.

Plate 14: North-west elevation of the foundation of the Main Mill, wall 019 (2m scale, 20cm increments) Note the stone courses, brick infill and later truncations

Within the area of wall exposed at the rear of the privy tower, the base of the exposed wall comprises two courses of roughly-dressed and tooled, rectangular stone blocks, each 1' (0.30m) tall, the lower being submerged below the water table (Plate 14). This differed markedly to the area of exposed plinth to the north of the privy tower, which although not excavated to the same depth, did not have any evidence for a stone footing to the plinth at a similar level, instead having a continuation of the face of great' bricks (Plate 15). Both sections of the wall face have a further course of 8" (0.20m) thick dressed sandstone, placed 2'6" (0.76m) below ground level, and similarly cut to that within the privy tower below (Plates 14 and 15). As described above, the exposed stone block at the southern end of the privy tower was cut to project beyond the wall face of the Main Mill, keying it into the brick wall of the privy tower (Plate 12). Within the area of the privy tower, the space between the two elements of stone courses within the Main Mill wall plinth was infilled with seven courses of brickwork. This included both hand-made and machine-made brick, with all but the lower course, which was of stretcher facing, comprising a mixture of headers and stretchers (Plate 14). It was tightly bonded in a grey cementitious mortar, clearly representing a refacing, or rebuilding of this part of the wall, but continued behind the two areas of infilling (***023*** and ***025***) within the side walls of the privy tower (Plate 14).

Plate 15: North-west elevation of the mill foundation visible to the north of the privy tower. Note the soot-staining on the face of the wall

To the north of the privy block, the upper stone course represented the extant upper surface of the plinth (Plate 15), possibly representing the original layout of the wall in this position, whereas within the privy tower, the stonework was capped with a course of thin tile below a single course of header bricks (Plate 14), representing the present upper level of the plinth. The bricks were of similar section to the ‘great’ brick within the privy tower, suggesting that the original plinth again differed from that to the north of the tower.

Both the upper band of stone and the brick and tile course above were cut by a late ceramic drain, placed within a clay fill of its trench (Plate 14), and presumably dating from the later phases of malting occupation of the site. Below this, and cut through the brick infill between the two stone elements of the wall was an irregular cut retaining the broken section of a ceramic elbow reducer pipe from a water closet. This almost certainly dates from the installation of flushing toilets within the privy tower, possibly predating the closure of the flax mill in the 1880s. The pipe lies within the upper part of a cut infilled with concrete, which extends into the cut for the pipe above, and has the later ceramic salt-glazed pipe embedded within its upper surface (Plate 14), demonstrating that the concrete is contemporary with the later pipe, that almost certainly replaced the earlier plumbing for water closets. The concrete has large brick inclusions, similar to late floors within both the north and south engine houses, suggesting a date around the turn of the twentieth century for its insertion, corresponding to the earliest phase of the use of the complex as a maltings.

Two further pipes were cut through the east wall of the mill in the western section of the excavation trench to the north of the privy tower (Plate 15). The lower of these was a cast-iron pipe, placed within a round cut through the brick wall, with concrete infill around the pipe similar to that observed within the wall to the south (Plate 15), suggesting that it related to the early maltings phase around the turn of the twentieth century. A ceramic pipe set within a brick surface drain projected from the wall above the height of the plinth (Plate 15), and appears to be of much later twentieth-century date.

The Chimney

The base of the chimney was exposed in the eastern part of the excavation trench, at the relatively shallow depth of 0.55m below present ground level (Plate 16). The broadly rectangular structure had maximum dimensions of 6.73 x 5.28m and survived to a maximum depth of 1.15m below its upper extant surface. It had four main components, comprising a stone base, a brick superstructure, a vertical shaft, and two horizontal flues (Fig; Plate 16).

Plate 16: Chimney base revealed in the eastern half of the excavation, looking north-east (2m scale)

At the base of the chimney was a stone footing, presumably forming a solid base across the entirety of the structure. Two courses of sandstone blocks, each of approximately 0.18m height, were visible in the western elevation of the chimney base (Plates 17 and 18). The upper course of stone had been exposed to extreme heat, following remodelling of the chimney base in the 1870s, causing both discolouration and deterioration, making it hard to determine its natural hue, which varied from light orange to yellow. The lower course of masonry appeared less damaged. The remainder of the stonework was obscured by a skin of refractory bricks (***015***), which faced the remainder of western side of the chimney base (Plate 17).

Plate 17: West elevation of the chimney showing exposed courses of stone base, partially obscured by a later skin of firebrick (2m scale)

Plate 18: Close-up of exposed stonework at the foot of the chimney base (0.50m scale)

Above the stone foundation, the structure comprised a mixture of hand-made and refractory bricks, typically measuring 9 x 4 x 2¾" (0.23 x 0.10 x 0.08m), consistent with common dimensions of the mid-nineteenth century. The original core of the brick structure survived to a maximum extent of 6.7 x 5.2m, and was exposed to a height of 1.1m, but continued below the limit of excavation. The surface was irregular and pitted and had become reddened in places, due to heat, as well as being blackened with soot. On the western side of the central 3' (0.91m) wide flue, the majority of bricks were laid at a 45° angle to the structure, apart from the southern 6'3" (1.91m), where they were laid in horizontal east/west-aligned rows, parallel to the structure. Several patches of repair were also placed in a horizontal direction. To the east of the flues, all the brickwork was laid in horizontal rows (Plate 19). The horizontal flues ran through the surface of the chimney base, from north to south, and through the central vertical shaft of the chimney (Plate 19). Each was of approximately 3' (0.91m) internal width at its surviving upper limit, which appears to have represented between one and three courses below the springing point of the rounded base, presumably below vertical walls and a rounded arch capping within the original construction. The walls of the flue comprised a full-brick thickness of refractory bricks, and whilst these appear to have been laid in stretcher bond in plan view (Plate 20), they were actually laid as two courses of edge-set brick, clearly seen in profile within the vertical shaft of the chimney (Plate 21). The brick was bonded with a pale greyish mortar, heat-discoloured in places to a pinkish-red hue, and overlay the core of the chimney base, which was of hand-made brick (Plate 22).

Plate 19: The chimney base from the north, with remodelled flue from the boiler house in foreground

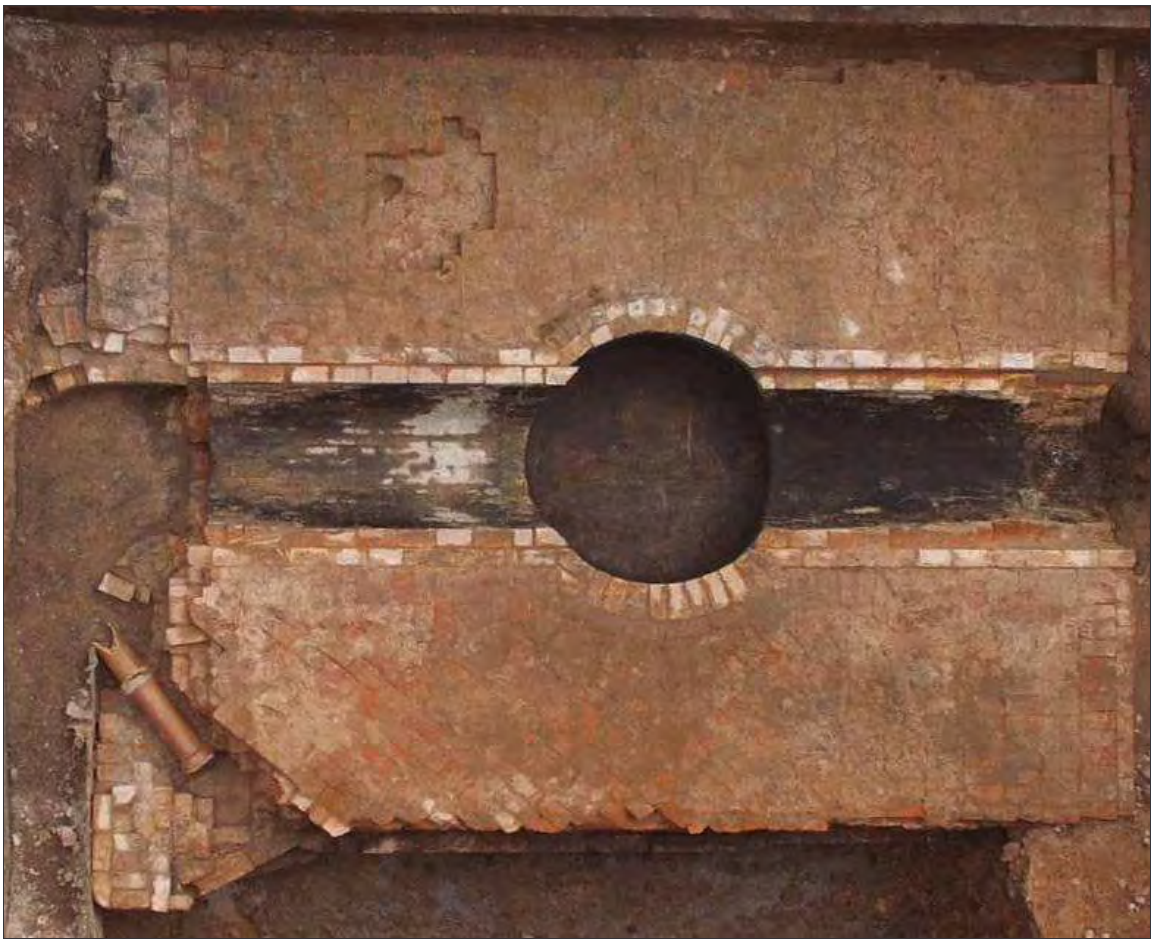

Plate 20: Aerial view of the chimney base, showing refractory lining to all flues

Plate 21: Profile of horizontal flue, with stone base of vertical shaft

The flue was badly damaged at its northern end, but retained remnants of a steeply sloping ramp of heavily degraded and sooted refractory brick (Plate 22), demonstrating that the flue from the rear of the boilers was placed at a lower level. The curving wall of the flue also survived on the western side of this ramp, providing a smooth curve for gases from the rear of the northern boiler house into the base of the chimney (Plate 20).

The eastern side of this flue aperture had been remodelled, but retained a rebate in its eastern wall at the top of the ramped section of wall, suggesting the position of the cast-iron housing for a damper (Plate 22). The ramp at the southern end began within the main body of the flue, with sooted sloping refractory bricks continuing immediately to the south (Plates 7 and 23). Furthermore, there was no evidence for a damper, as at the northern end of the chimney base, suggesting that it formed a seal on the northern side of the chimney in the period between the construction of the southern and northern boiler houses.

Plate 22: Ramp at northern end of horizontal flue, with position of possible damper surround at junction with chimney base

Plate 23: Ramp at southern end of horizontal flue, beginning within the chimney base

The base of the vertical shaft of the chimney initially appeared to have been positioned slightly off-centre, on its western side (Plate 20). However, the removal of the original western part of the chimney base plinth, and its refacing with a stepped wall of refractory brick suggests that the chimney base was originally of similar width, with the vertical shaft placed centrally, as shown in original drawings of the mid-nineteenth century (Plates 2 and 3).

The circular shaft was of 5' (1.52m) internal diameter, and was lined with refractory bricks, similar to the horizontal flues with which it was contemporary. At the level of the horizontal flues, the lining comprised exclusively header brick, except at the junction with the flues, where special chamfered refractory bricks were used, with different profiles butting the inner and outer skins of the flue wall (Plate 24). Below flue level, the chimney stack was of narrow stretchers on the internal face, and these were heavily sooted (Plate 24).

The base of the shaft, at a depth of 0.67m below its upper survival level was of large, dressed, rectangular sandstone blocks, placed at a similar level to those observed in the western elevation of the base (Plates 21 and 24), and bonded with a light yellowish-white, sandy lime-based mortar.

Plate 24: Base of vertical shaft of the chimney looking north-west (1m scale)

Traces of a sand-based render survived in patches, predominantly around the edges of the base (Plate 24), suggesting that it was originally sealed to protect the stonework from the heat of the chimney. The lower 0.20m of the shaft base had been infilled with soft boiler ash, overlain by demolition debris. Similar debris was also encountered within the connecting flues.

A series of flues of more than one phase of construction survived to the immediate north of the chimney base (Plate 25) To the north-west of the chimney base, a remodelled wall (***010***) represents the rear wall of the flue from the northern boiler house to the chimney (Plates 25 and 26). The original element survived to a height of 0.83m and length of 1.75m from the east wall of the Main Mill, with its southern edge placed level with the northern extent of the chimney base (Plate 25). It appears to have been of 1'8" (0.51m), two-brick thickness, although much of this was removed from the northern side during the subsequent remodelling. It comprised hand-made brick, of similar dimensions to those within the chimney base, and was bonded with light, greyish-white lime-based mortar, strongly suggesting a mid-nineteenth-century date, consistent with the construction of the northern boiler house.

Plate 25: Flues to the north of the chimney, partly forming the south gable of the northern boiler house

Plate 26: Walls 010 and 013 looking south-east. Note the crude joint of wall 010 at the south-east end of wall 013 (1m scale)

A similar thickness wall (***014***), placed on the northern side of the chimney base formed part of the horizontal flue entrance at its eastern side, and had been at least partially remodelled at its western end for later use. In the north-eastern corner of the excavation trench, further remains of a similar flue wall (***08***), butted the north side of the chimney base (Plates 25 and 27). This had again been heavily remodelled following the replacement of the northern boilers in 1874/5 to form a terminus for a bypass flue into the chimney.

Plate 27: View of walls 008 and 009 constructed to the south of the chimney base 006 (1m scale)

Wall ***013*** had been encased on its northern side by later walling (***010***) built in refractory brick, widening and extended the structure by 1'6" (0.46m) in length. In plan, the northern face of the wall was curvilinear, with its joint being clearly visible in plan (Plate 26), with the vertical butt joint between the phases visible in the southern face of the wall (Plate 28). From the south-east corner of wall ***010***, the face of the wall curved through 90° using bull-nosed brick to form its northern side, which widened gradually to approximately 0.40m from the west end of the wall, from where it curved more steeply to the north. This second phase of the wall was constructed in refractory brick bonded with a crumbly, light white lime-based mortar.

Plate 28: Walls 010, 013 and 014 and iron damper frame (0.50m scale)

The opening between walls ***010*** and ***014*** was 2'6" (0.75m) wide and housed the framing for a cast-iron damper, with parts of either side and the base surviving ***in-situ*** (Plate 28). Two bolts to either face suggest that the upper part was either formed as part of a separate casting, or had been repaired or modified at some point (Plate 29).

Plate 29: Metal damper constructed against the opening on the south-east side of walls 010 and 014 (0.50m scale)

Part of the wall had previously been exposed during trial hole excavations in 2017 (OA North 2018), revealing the northern side of the wall to a depth of 1.85m below ground level (Plates 5 and 6). The partial floor of a flue of 0.56m width butted its southern side, and formed a surface to the north-west corner of chimney. The opposing side of the flue had been shuttered with plywood sheeting following the excavation in 2017, and was not exposed during this phase of work (Plate 29). The earlier trench revealed it to have been of similar construction, and incorporated a blocked, segmentally-arched aperture of 2'6" (0.76m) width, that almost certainly represented the housing for the flue damper of the western of the three boilers placed within the northern boiler house (Plate 6).

Several of the refractory firebricks used in the linings of the modified flues bore a 'RUFFORD STOURBRIDGE' stamp (Plate 30). The Stourbridge fireclay industry has a long and illustrious history, counted among a handful of regions (including Strathclyde, Scotland, South Wales and Yorkshire) for the production of firebrick and refractory materials. A brick works was opened by Francis Rufford in Stourbridge in 1812 and was operational throughout the nineteenth century, ceasing production in 1936. It is unclear whether this remodelling was contemporary with that to the direct west of the chimney base, or formed a later alteration, once the demand for steam power reduced in the later part of the nineteenth century.

Plate 30: An example of a stamped firebrick, product of 'Rufford, Stourbridge' found within wall 008

The single-skin lining of refractory brick added to the western side of the chimney base was contemporary with that applied to the eastern external face of the privy, and the remodelling of the cross wall that formed the southern extent of the northern boiler house (Plates 20 and 25). At its northern end, the lining had a distinctive dog-leg to the north-west, which was of differing angles within the surviving fabric. All bar the upper extant course appear to have formed the base of the chamber, and were placed at an 18° angle to the west wall of the chimney base (Plates 25 and 31).

The upper extant course continued for an additional 0.42m on the alignment of the chimney base, before returning at a greater 27° return to butt the cross wall flush with the internal face of the cast-iron damper (Plates 25 and 31). This upper angle is very diagnostic of the walls carrying an economiser base, where the exhaust chamber below is expanded to the width of the economiser house. To the south, the remodelling of the chimney base is represented by a stepped re-facing, following the removal of the original outer part of the structure on its western side, to facilitate the insertion of an economiser into the space between the chimney and privy tower. It appears that part of the base was left exposed, as seen in the excavation, explaining the severe heat damage (Plates 17, 18 and 31), not seen elsewhere.

Plate 31: General view of the north-west side of the chimney base, looking over the economiser bed

5. Discussion

5.1 Introduction

The excavation revealed well-preserved remains of the privy tower, chimney, and flues associated with the northern boiler house. These have been ascribed to four main phases of activity, commencing in the late eighteenth century with the construction of the original spinning mill and privy tower. Two large boiler houses and an associated chimney were added to the eastern side of the complex in the 1840s and 1850s, reflecting a technological remodelling of the entire complex, followed by a third phase of remodelling the power plant in the 1870s. The final phase, relating to the use of the complex as a maltings from the late nineteenth century comprised the demolition of the earlier features and the placement of a single-storey warehouse in its place.

5.2 Phase 1: Late Eighteenth Century

Main Mill: the earliest remains encountered were those belonging to the Main Mill, which was begun in 1796. A section of the east external wall of the original mill structure was exposed within the excavation area. This comprised a wall face within the footings of the privy tower, and an area immediately to the north. Although slightly confused by later probable underpinning, it was clear that the two elements differed in their construction, with the exposed wall face within the privy tower having a stepped sandstone plinth, whilst the exposed wall face to the north had no evidence for the upper surface of these blocks (Plates 14 and 15). Both sections of wall had a sandstone course, placed 2'6" (0.76m) below present ground level, those within the privy tower including a dressed block that returned to form a keyed joint with the south wall of the privy tower. Whilst these blocks may have been removed and replaced during what appears to have been an episode of underpinning below, it is highly unlikely that they represent newly cut stones at this time, when the use of iron supports would have been a much more cost-effective way of securing the base of the privy tower to the plinth of the main structure if required.

Within the privy tower, this course of sandstone was capped with tile and edge-set 'great' bricks – distinctively large brick associated with the earliest phases of construction of the Flax Mill complex in the late eighteenth and early nineteenth centuries, prior to 1805. To the north of the privy tower, no such capping of the sandstone course survived, either having been removed, or possibly representing a further difference in construction within the footings of the east elevation. The bay division adjacent to the privy tower marks the position of a proposed break in construction between the original mill, and a ten-bay extension (MacLeod ***et al*** 1988, 10), and the differences in the foundation certainly support this hypothesis.

The northern bay of this proposed original phase was much narrower than the adjacent bays, and has blocked apertures in the east wall (Plate 32). The upper brick vault of the bay is spanned by the pitched roof of the adjacent bay (Plates 32 and 33), being seen as a single wide bay externally (Plate 32), with the narrower bays of the northern part of the mill, and slightly wider bays to the south clearly identifiable following the refurbishment of the roof (Plate 32).

Plate 32: General view of the east face of the Main Mill, with the excavated privy tower and chimney base in foreground

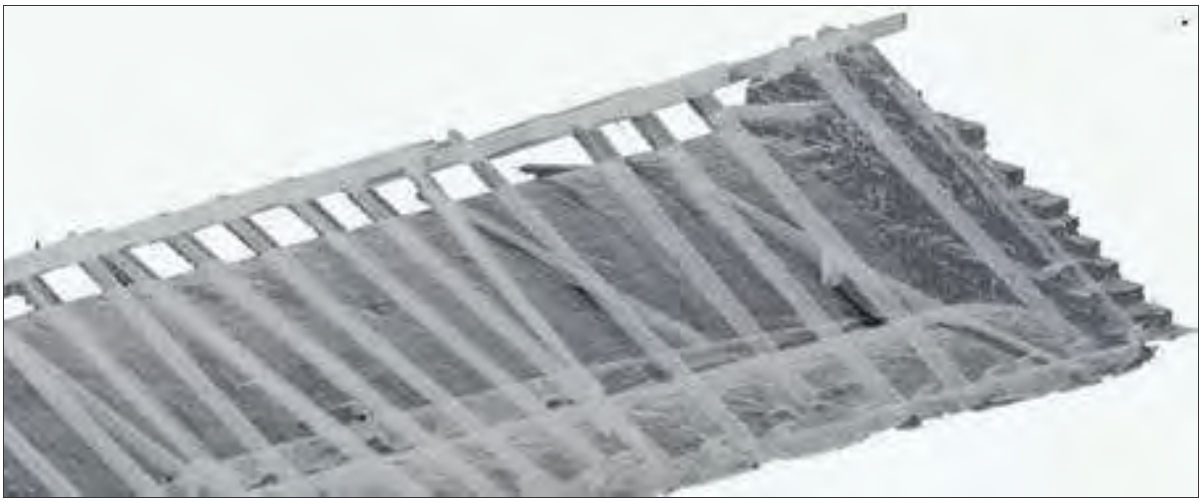

Plate 33: Extract from point cloud model showing the pitched roof spanning two brick vaults at the junction between the original and extended mill

Privy Tower: the development of privy facilities is a little studied aspect of textile mills. Mills were designed primarily to provide working spaces which were as uninterrupted as possible (Giles and Goodall 1992, 27). As the size of mill complexes grew in response to the availability of larger machinery, and increased demands for cotton goods, 'the problems of the movement of raw materials and goods, of access for workers, and of sanitary facilities, raised themselves' (***ibid***).

Sanitary facilities in late eighteenth- and early nineteenth-century mills were generally rudimentary, and provision for privies was rarely provided in any other than the larger mills (Giles and Goodall 1992, 27). Examples of early mills equipped with adjoining privy towers include Peter Drinkwater's Piccadilly Mill of 1789 (Williams with Farnie 1992, 51), Murrays' Mill of 1798 in Manchester (Miller and Wild 2007) and Chorlton New Mills, Manchester established 1814 (Hartwell ***et al***, 2004, 48); in these cases, the privy towers projected from the main spinning blocks. These early privy towers were of a square or rectangular plan, usually lacked windows, and were equipped originally with only simple, if any, plumbing. The position of the privy tower at Ditherington, placed approximately centrally on its eastern elevation is consistent with those of early Arkwright-type mills, where present. It spans the junction between the two phases of the spinning mill, strongly suggesting that it was contemporary with the latter, and probably of similar date to that at the original Old Mill in the Murrays' Mill complex, which was a significantly smaller structure. It is noteworthy that neither of the two subsequent spinning blocks at Murrays' Mill, erected in 1802 and 1805 included privy towers, demonstrating that they were not becoming a more prevalent feature in the early adoption of the factory system.

A later improved arrangement of early privies can be seen at Marshall's Mill of 1815 in Holbeck, West Yorkshire, where the privies were grouped against the gable wall of each floor, with each compartment lit and ventilated by small circular windows (Giles and Goodall 1992, 27). This is of particular significance, given that the site was under the same shared ownership of Marshalls, with their mills at Ditherington and Holbeck.

By the mid-nineteenth century, many mills were equipped with privies. In multi-storey spinning blocks, the privies were sometimes set at or close to the corner of the building. More frequently, however, they were situated in projecting towers that housed one or more closets on each floor. These towers were either rectangular or polygonal in plan, and the larger mills often had more than one privy tower. These commonly housed dry-chute toilets with a collection box at the foot of the tower (Greenlees 2016) a fine surviving example being provided by Brook Mill in Congleton. This privy tower, built in 1835, retains small openings to each floor and an open ashlar collection point at the base for removal of the soil. Privies were generally of the dry-chute type until the latter part of the nineteenth century, when water closets were first installed (Calladine and Fricker 1993, 118).

Projecting privy towers remained a feature of some late nineteenth- and twentieth-century mills, such as Paragon Mill of 1912 in Manchester, although from the mid-nineteenth century privies were more commonly built into the corners of the main mill block, sometimes disguised as pilasters, or incorporated into the stair tower (Williams with Farnie 1992, 99).

The construction of the privy tower at Ditherington was examined in detail during the excavation. Although the stone plinths of the privy tower foundation appeared to butt those of the main structure, and the brick walls above did not have a clear relationship with any visible, original fabric of the mill, the course of stonework at the upper level of the Main Mill footing was clearly keyed between the two structures. If as suspected, the privy tower was erected shortly after the southern part of the spinning mill, it appears that the keyed stone block may have been inserted at this time to bond the new tower and extended mill into the original fabric.

The privy block is not depicted on the earliest plan of the mill dated 1811. However, this plan lacks the level of detail of those from 1849 and 1855, with the primary purpose of the drawing being to show the location of gas installations within the mill, and details such as the privy tower may have been considered unnecessary. Furthermore, the external walls of the privy tower are of ‘great’ brick construction, and given that it is highly unlikely that its foundation was built entirely from re-used brick, it is almost certain that the structure dates from prior to 1805, when smaller, more typically-sized bricks were used across the site, and was contemporary with the northern extension of the spinning mill prior to 1800.

The depth of the foundations of the privy tower also supports an early date of construction. Had the tower represented a later addition, it is highly unlikely that it would have included such a deep foundation, matching that of the level of the much larger Main Mill. The large stone plinth at its base, and great depth below ground level, that would have been unused space, most probably relates to it being placed within the wider foundation cut/earth movement associated with the construction of the larger mill.

Sanitary provision has previously been presented a ’mundane aspect of working practice‘ that was overlooked by Charles Bage during the design of the late eighteenth-century spinning mill at Ditherington (Giles and Williams 2015, 39). A conservative estimate was that the privy tower was built in the intervening period between the plans of 1811 and 1849. It does seem impractical, however, that the Main Mill could have operated efficiently without the provision of adequate facilities for its large workforce, with privy towers being a not uncommon feature of late eighteenth-century mills. The evidence revealed by the excavation strongly suggests that the privy tower dates to the earliest phase of the mill, as part of its extension prior to 1800 at the latest.

The layout of the privy tower can be seen from the detailed plans of 1849 and 1855, and from a photograph taken in the very late nineteenth century, shortly before its demolition (Plate 34). The image shows the privy tower, partially obscured by the chimney, but being of very plain brick construction to the full height of the elevation, where it was capped with oversailing sandstone copings (Plate 33). It also appears that the main east face was devoid of windows, again suggesting an early date of construction. This is confirmed on the plans of 1849 and 1855 (Plates 35 and 36), which show no openings to any of the external elevations.

Plate 34: Photograph from the late nineteenth century showing privy tower (orange), chimney (red) and boiler house (green) positioned in front of the Main Mill

The type of privy installed within the tower is open to debate. In its early stages, prior to the construction of the boiler houses and chimney, it may have either supported a dry-chute and collection pit arrangement or simpler, pail closet. The former would have relied on access to the base of the tower on the eastern side of the mill for collecting waste. Archaeological evidence of a collection pit to support this is lacking. An alternative arrangement would have been the placement of buckets below fixed privy seats at each floor within the mill. The latter again cannot be proved archaeologically and whilst it remains a possibility, the emptying of the pails would have been impractical and unwieldly. Turning once again to the 1855 plan, it can be noted that by this stage an earth-pipe had been inserted into the privy tower, possibly to collect effluence from the privies and carry it away from the mill, as part of a long-drop arrangement. The plan indicates the pipe led out to the meadows on the western side of the mill.

Plate 35: Extracts from the 1849 and 1855 plans showing the privy tower

5.3 Phase 2: Mid-Nineteenth Century

A major overhaul of the steam-production plant was necessitated by the construction of a new dye house in the 1840s. Although the demand for steam engine power was decreasing within the complex at this time, the new dye house, constricted to the west of the Main Mill, had a much greater demand for hot water, heating pipes and steam. The solution was to erect a large boiler house in the gap between the eastern side of the spinning block, and the canal. It comprised two buildings, each housing three large 60'-long boilers, with a tall free-standing chimney placed between the two. The boilers, which would have been Cornish boilers in the southern house, and possibly relatively newly-patented Lancashire boilers in the later 1850s house, were charged from their outer end, with coal presumably delivered directly from the adjacent canal, with the southern coal yard being marked on the detailed plan of 1849 (Plate 2). This plan shows that only the southern of the two boiler houses had been erected by this date, as well as the chimney, although it clearly depicts the flue in the northern side of the chimney base, built in preparation for subsequent addition of the northern boiler house (Plates 2 and 35).

Documentary sources show that there was a significant time delay between the construction of the southern boiler house and chimney in 1840-41, at costs of £600 and £900 respectively (LULSC MS200/4 f278), and the northern boiler house, that is not shown until the detailed plan of 1855, having been built in 1852-3, at the much greater cost of over £1,000 (LULSC MS200/4 f276). This perhaps reflects the increased cost of Lancashire boilers over the older technology of Cornish boilers.

Plate 36: Extracts from the 1849 and 1855 plans showing the cross section of the chimney base

The excavation confirmed that the flues within the chimney were built as a single phase, with the horizontal flues comprising a refractory fire-brick lining to channels of hand-made brick. The base of the structure comprised large sandstone blocks, of at least two courses depth. Stone was also revealed at the base of the vertical shaft, confirming that this formed a solid base across the entire structure. Above the masonry, the footing was formed of brick, commonly used in industrial chimneys of this period, it being lighter than stone, and easier to build into the conical or multi-facetted chimney that had become popular by the mid-nineteenth century. The bricks were laid in regular courses but with no uniform or identifiable bond visible in the extant upper course. Whilst the majority of the brick had been laid in rows, perpendicular to the sides of the structure, a large portion of the brickwork on the western side of the base were arranged in diagonal rows (Plate 20). It is not known whether mismatch in brick patterns was unintentional or a conscious decision to help key alternate courses of brick together.

The flue interiors were lined with firebrick, a refractory ceramic that could withstand high temperatures and was commonly applied to the lining of furnaces, flues and boilers. According to a late nineteenth-century authority on mill construction, an internal firebrick lining was typically found on the lower half of the chimney and preferably built with a cavity between the lining and brickwork (Nasmith 1894, 162).

The first use and recognition of fireclays in the production of refractory materials is open to debate. The development of this industry occurred as a result of coal mining in the late eighteenth and early nineteenth century and the incidental discovery of fireclay seams, which were brought to the surface ***en-masse***. The nearest centre for fire-brick manufacture would have been located in Stourbridge in the West Midlands, with fire brick works such as Rufford and Co, in operation by 1802.

The plans produced in 1849 and 1855 show that the footings of the chimney were broadly square in plan, measuring approximately 20ft x 20ft (Plate 35). The extant remains confirm the details of the plans, with the foundations having a maximum recorded length of 6.2m (20'4") along its north/south axis. The internal configuration of the chimney was largely omitted from the plans, however, and it was only through excavation that the morphology and arrangement of the flues was established. The base of the vertical shaft was circular, fed by two horizontal flues positioned to the north and south. The horizontal flues had concave bases and would have had vertical sides below a round-headed roof. The north flue is indicated on the plan of 1849, demonstrating that, although the southern boiler house was built over ten years earlier, the intention was always to add a further structure to the north, the flue apparently being closed with a damper in the intervening period.

Excavation revealed that any evidence for the above-ground chimney stack had been removed during ground reduction in the late nineteenth century. Both plans show it to have had a dodecagonal shaft above a circular tiered plinth to a square base, and with a central cylindrical shaft (Plate 35). The late nineteenth-century photograph, taken from the road looking west (Plate 33), reveals that the base of the above-ground structure was relatively ornate. Although partially obscured, it shows that the circular offsets were of rolled stone below the slightly tapering faceted brick shaft.

The 1840-41 chimney represented by far the largest of the chimneys built within the flax mill complex. By comparison, the earlier northern boiler-house chimney (built circa 1800, and still extant in the 1840s) measured approximately 10ft x 10ft (Plate 36). This was of square section, typical of early mill chimneys, and was built directly against the walls of the boiler house, also a common feature in early mills (Giles and Goodall 1992, 151-152). The original chimney of the southern boiler house is not shown on the plan of 1849, but was similarly placed at the rear of the boiler house, and can been seen to be of square section on the original Boulton and Watt drawings (MS 3147/3/406/31-40), and was probably of similar or smaller proportions to that of the slightly later northern power plant (Plate 36).

The replacement of earlier chimneys with larger structures occurred in tandem with developments of steam-powered plant and boilers. Much taller chimneys were required to create the draught necessary for houses containing multiple large boilers from the mid-nineteenth century. These taller structures were more susceptible to wind, and as a result, the profile changed from square to polygonal or circular over time.

The octagonal form became the most common in mid-nineteenth century mills (Giles and Goodall 1992, 151), with the dodecagonal example at Ditherington being somewhat unusual. Many of these larger chimneys were detached from the mill, and often from the boiler house, placed on hillslopes to improve draught by using long, yet easily constructed, flues.

The new chimney at Ditherington did not need any additional draught, due to the relatively flat topography, and was ideally placed to serve the two boiler houses, each connected by a short flue into opposite faces of the base of the chimney, sited between them, but detached from the mill (Plate 37), again representing a relatively uncommon solution to the issue of exhaust management.

The chimney would have been functional prior to the construction of the second, northern boiler house, with the flue presumably having a temporary blocking until construction of the latter was completed in 1853. Evidence for a damper housing revealed in the northern end of the northern horizontal flue almost certainly served this function, and would have allowed access into the base of the chimney for maintenance if required, rather than a temporary brick blocking.

Evidence also survived for the footings of the southern gable wall of the northern boiler house, which at this lowest level, also formed the rear of the flues from the three boilers into the chimney. They appear to have been of hand-made brick construction, with a refractory brick lining, with a severely heat-effected bull-nosed return of the flue into the chimney. The wall had been significantly remodelled by later alterations to the steam-producing plant.

A sloping fire-brick base extended from the chimney into the east/west-aligned flue, which directed the exhaust gases from the three boilers into the chimney. An arched flue entrance set within an additional parallel wall located to the north of the chimney base, identified during the earlier watching brief (OA North 2018), represents one of three probable openings through which the exhaust gasses passed from the boilers into the flue (Plate 6).

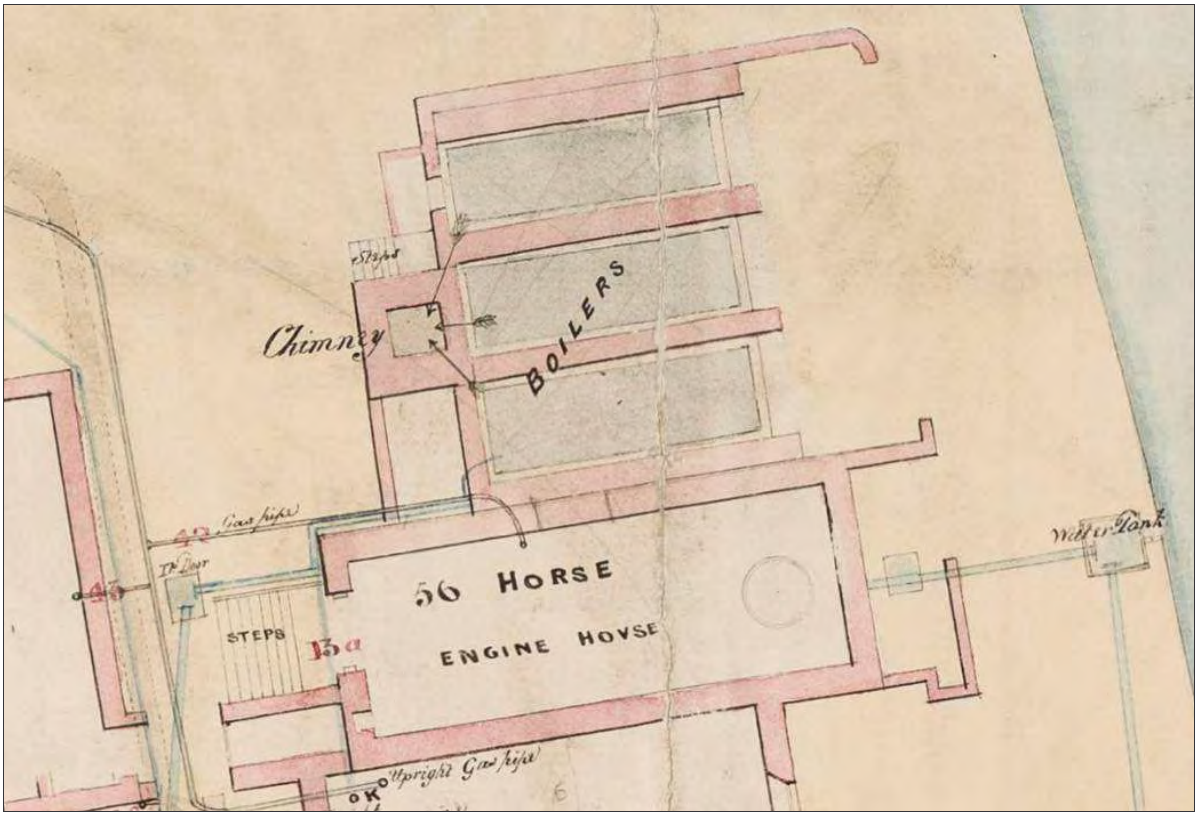

Plate 37: Extract from the 1849 plan of the mill showing the northern engine and boiler house. Note the integrated square chimney on the western side of the boiler-house

Plate 38: Extract from the 1855 plan showing the completed boiler-houses

Modifications were also undertaken to the privy tower around this time. Whilst it is probable that the original privies contained pail closets, the detailed plan of 1855 depicts and annotates an ‘earth pipe’ leading beneath the mill to the west from the northern edge of the privy tower (Plate 39). This is labelled on the plan as ***53*** ‘[an] earthpipe drain leading from privy’s on the east side of the mill, running under the mill, yard and south end of the dye-house to meadow’. The rendering of the privy on the 1855 plan indicates the structure was divided into two cubicles; seats or buckets can be seen on the south-east wall of the structure. The pipe, which was not shown on earlier plans, appears to indicate modernisation of the facilities by the 1850s, probably following the erection of the boiler houses to the east of the tower. This pre-dates the invention of the flushing water closet by some time.

The depiction of probable seating against the east wall does raise the possibility that the original pail closets (which themselves would have had a bench or seat above), might have been replaced with a long-drop dry chute arrangement. The soil pipe would then have served to remove liquid waste below ground level, whilst the nightsoil could have been raked from a hatch, probably inserted into the north or east wall, which could have been accessed from a doorway in the east wall of the Main Mill immediately to the north of the privy tower.

It is noteworthy that a small block of external privies, built to the west of the Apprentice House by 1849 has a ‘soil tank’ placed on its western side, suggesting the use of pail closets that were emptied manually into the tank. This is also shown on the plan of 1855, although not named, with a wash house, supplied with gas from the 1835 gas plant to the west, presumably for hot water, also depicted (Plate 40). This shows that facilities for the workforce were improved through the nineteenth century, reflecting the national picture.

A cluster of workers’ cottages were constructed as part of the original land purchase in 1797, but the Marshalls did not expand this into a paternalistic textile ‘village’, as at the broadly contemporary complex of New Lanark, South Lanarkshire, or the mid-nineteenth century Saltaire Mill complex in West Yorkshire. The Marshalls were far more socially active in the Holbeck community associated with their Leeds factory, providing schools and a church (Belford and Trinder 2015, 119).

Plate 39: Extract from 1855 plan indicating the 'earth pipe' entering the privy tower below the mill floor

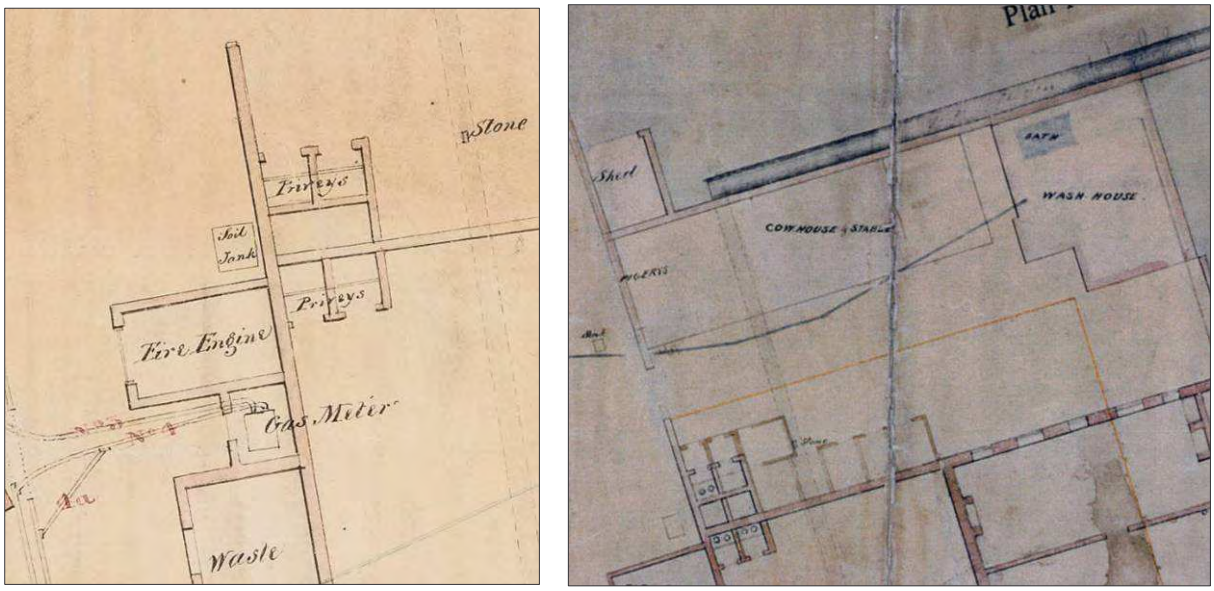

Plate 40: Extracts from the 1849 and 1855 plans of the mill showing the privy block serving the northern part of the site and the wash house. Note the presence of an external 'soil tank', a feature absent in the vicinity of the privy tower

5.4 Phase 3: 1870s

Further modifications to the steam-producing plant were undertaken in the early 1870s as a result of dwindling demand for mechanised power by this date. The engines in both the north and south engine houses of the adjacent Main Mill were replaced around 1874 with 30HP single-crank Corliss engines, built and supplied by Hicks & Sons of Bolton (LULSC MS200/47). The documentary sources also suggest that this was accompanied by the replacement of the 60' boilers in the northern boiler house with a set of three Howards boilers in 1875 (LULSC MS200/4 f276). However, the excavation evidence clearly demonstrates that the eastern part of the flue was blocked, making the eastern flue of the original boiler house redundant. The reason for this blocking almost certainly relates to the installation of an economiser, as mentioned in the same entry within the Marshall's archive, demonstrating that an economiser was installed concurrently with the Howards boilers.

The economiser was patented by Edward Green in 1845, and utilised hot exhaust gases to preheat water entering a boiler. Once it was demonstrated how much fuel could be saved by installing an economiser into the power plant, uptake was rapid over the next few decades. Unfortunately, the first of the two boiler houses at Ditherington was constructed prior to this invention, and it appears that the layout of the northern boiler house was also fixed at the same time. By 1851, when the second boiler house was begun, the potential cost-savings of installing an economiser would not have been fully realised, with its major uptake following its demonstration at the Great Exhibition of that year, so it appears that construction continued without incorporating an economiser. Once their economic benefit had been established, the layout of the eastern boiler houses at Ditherington made it uneconomical to easily add such a feature, that needed to be placed between the boiler and the chimney, an area which had no access between the Main Mill and the canal. Thus, it was not until around 1875 that an economiser could be introduced into the power system at Ditherington. It is noteworthy that, even though the steam-producing plant was massively reduced in size, by at least 50% at this time, it was still considered economical to construct a new economiser house at this stage.

The new structure was placed in the small gap between the chimney and the Main Mill, a space made even tighter by the presence of the privy tower (Fig 3). The excavation and historic photographs show that the privy tower was retained, with a narrow economiser, of only 6' (1.83m) internal width, placed against the east wall of the privy tower, which was lined with refractory brick to protect it from the heat of the exhaust gases. The western-facing wall of the brick plinth of the chimney was reduced to the level of the base of the economiser, allowing it to be placed directly against the stone footings, and at its northern end, an additional lining of the outer face of the chimney was inserted, with an angled section, typical of the entry flue into an economiser.

This formed a narrowing of the flue chamber, butting the internal face of a cast-iron damper, the housing of which survived in the opening to the earlier flue from the boiler house to the north (Plate 29). Closing this damper would have isolated the economiser, allowing it to be cooled for maintenance, which was regularly required. The exhaust gases would instead pass along the original flue and into the chimney. Given that the economiser was sited at the western side of the northern boiler house, it would have been impossible to route exhaust gasses from the central and eastern boilers to the economiser through the existing flue, on the northern side of the chimney, whilst maintaining a viable bypass mechanism to isolate the economiser chamber. It is therefore almost certain that a new flue was built within the rear of the north boiler house, behind what would have been shorter Howards boilers, channelling the exhaust from all three boilers into a flue at the western side of the boiler house.

The existing flue aperture at the rear of the western boiler house that served the original boiler was blocked, as observed within the earlier excavation (OA North 2018), with a new flue placed at the western end of the wall, with wall ***010*** to the south having a curved profile on its western junction with the foundation of the Main Mill to facilitate the flow of gas into the existing flue (Plates 25 and 26). With the exhaust gas entering the original flue across the rear of the northern boiler house at its western end, the damper at the northern end of the economiser house could control flow through the economiser.

A further damper would have been required across the main flue, immediately to the east of the economiser damper, to prevent exhaust gases flowing directly to the chimney, rather than through the economiser, but no physical evidence survived for such a feature. In order to allow the smooth flow of exhaust gases to the chimney when this second damper was opened, to bypass the economiser, the original flue was blocked to the east of the horizontal flue into the chimney, with the curved wall across the flue revealed during the excavation, allowing the smooth flow or air into the base of the chimney (Fig 2; Plate 27).

Once the exhaust gases had passed through the economiser, they were undoubtedly routed through a remodelled flue at the rear of the southern boiler house, which was demolished at this time. This would have allowed the exhaust to be routed into the existing flue on the southern side of the chimney, creating a somewhat unusual but ingenious, economiser arrangement; a retro-fitted ecomomiser normally required the construction of a bypass flue that used the same aperture into the base of the chimney, whereas at Ditherington, the site layout and the double chimney aperture meant that the economiser was effectively the bypass itself.

The lower of two ceramic drains punched through the east wall of the Spinning Mill within the footprint of the privy tower comprised a ceramic reducer valve. This was clearly indicative of the use of water closets in the privy tower, although the date of their insertion is unclear. Water closets were not invented until ***c*** 1870, and their uptake was relatively slow commercially and domestically. The refurbishment of the steam-power plant to the immediate east of the privy tower significantly reduced the space within the courtyard around the tower, and would have blocked its east face at ground level. Whether the raking-out access for probable long drops was located in the north wall, which would have made emptying the southern privy complicated, or in the east walls, to the rear of both privies, the new arrangement of the economiser house would have hampered such a method of collection. It is therefore possible that the adoption of water closets within the spinning mill was undertaken around 1874/5 due to access issues to the exterior of the privy tower.

5.5 Phase 4: Late Nineteenth to Late Twentieth Century

The most recent episodes of activity have been associated with the adaptation and use of the site as a maltings. This was represented within the excavation area by modifications to the privy tower and Main Mill walls, subsequent demolition and installation of drainage. The entirety of the area was then levelled, the ground raised and covered over by a lean-to building with a concrete slab floor. The newly completed building first appears on the Ordnance Survey 1902 (Plate 41) and is also captured on a contemporary black and white photograph from ***c*** 1900 (Plate 33).

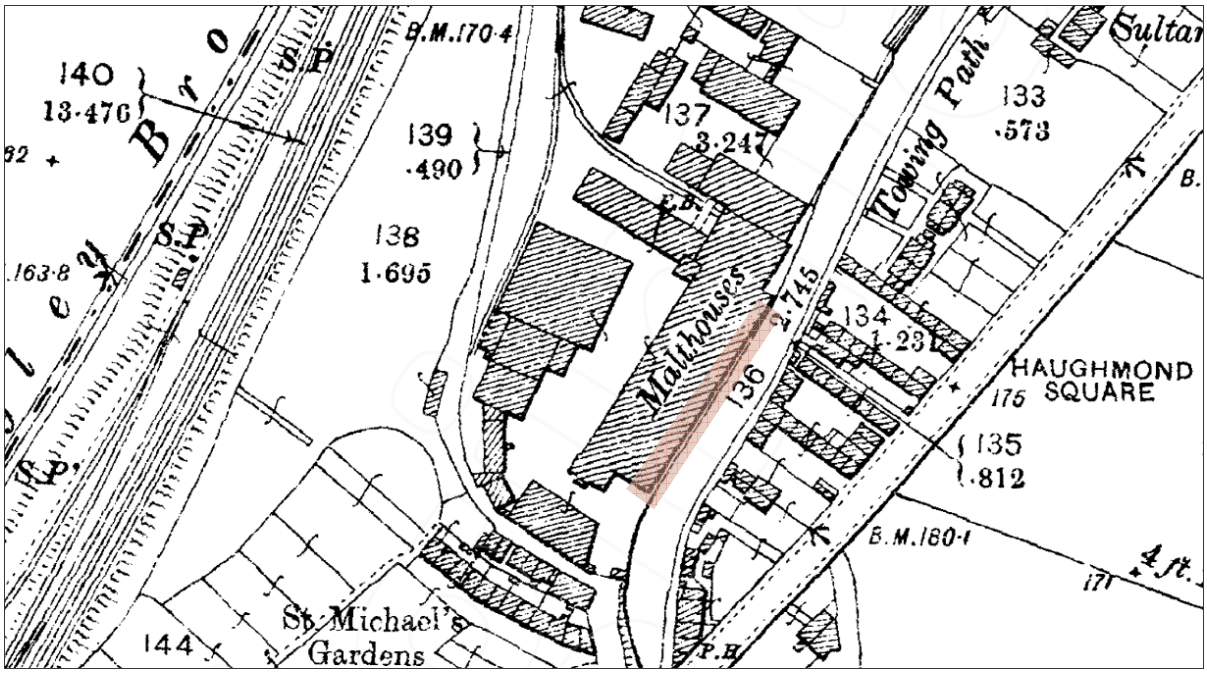

Plate 41: Extract from the Ordnance Survey 1:2500 County Series map showing the completed lean-to extension on the south-east side of the converted Main Mill (pink)

The demolition of the privy tower and boiler houses, surmised from cartographic and photographic sources, had occurred by the turn of the century. The structural remains were reduced to below ground level and was built up to the present level with redeposited clay subsequently. It was through this layer that a late drain had been cut; this also cut through the upper part of the mill foundation and the northern corner of the chimney. The position of the privy tower can be seen as a building scar, visible within the eastern external elevation after the demolition of the tower (Plates 32 and 42).

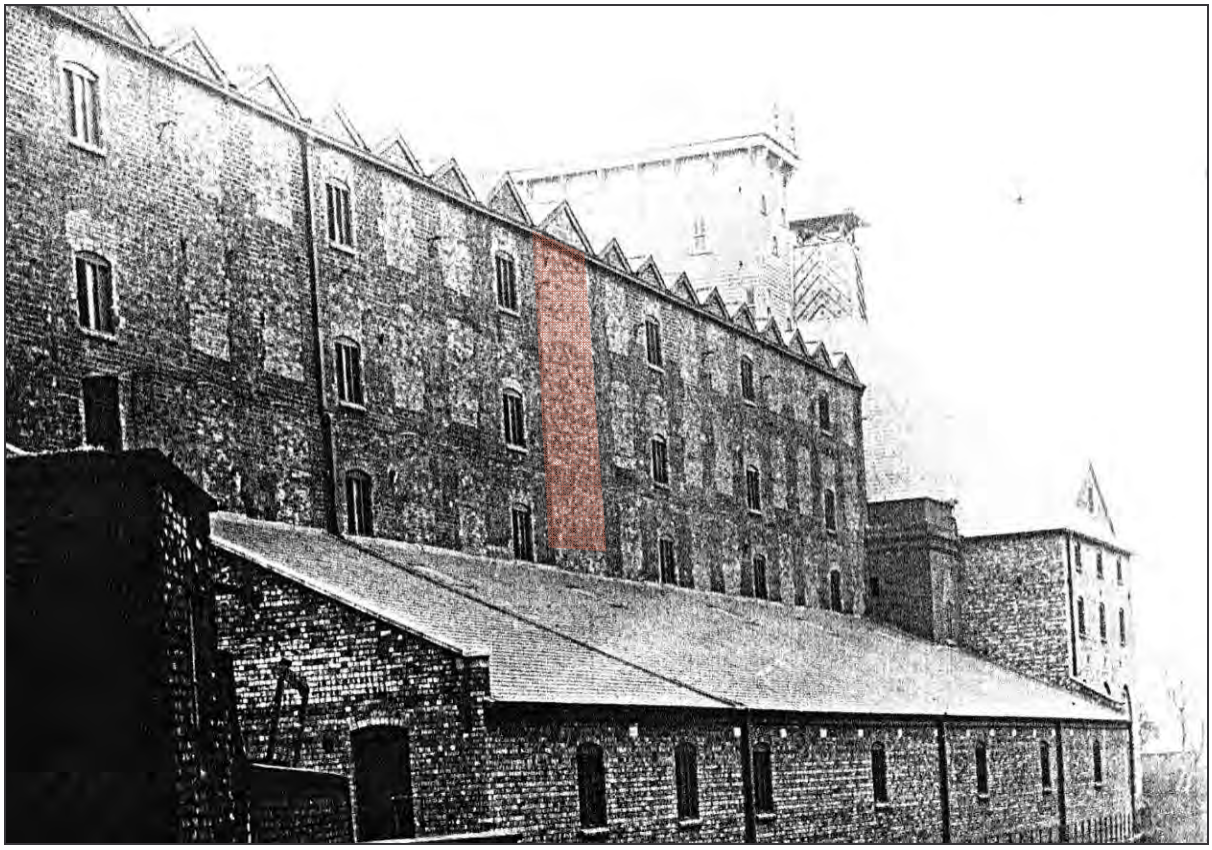

Plate 42: View of the eastern wall of the Main Mill; the scar-line of privy tower is highlighted in pink

A series of modifications had been carried out to the privy tower foundations towards the end of the nineteenth century, perhaps during or following the demolition of the privy tower and boiler houses. Clear signs that the wall had been repaired were visible in the upper courses of brickwork adjoining the Main Mill, which used a mixture of standard sized and 'great' brick that had been bonded with cement rather than lime-based mortar. Two episodes of crude infilling with brick was also noted on both sides of the privy. Underpinning to the Main Mill foundations involved refacing with machine-made bricks and reused stone. This work appears also to have impinged on parts of the privy tower, although the inserted brickwork simply butts the privy walls.

Acknowledgments

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The on-site excavations were conducted by Oliver Cook assisted by Andy Coutts, and with support from Chris Wild. The site survey and aerial photography was carried out by Chris Wild. The report was written by Oliver Cook and Chris Wild, and illustrated by Sarah Mottershead. The report was edited by Ian Miller, who was also responsible for project management.

Sources

Cartographic

Ordnance Survey 25” to 1 mile map of 1886

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Ordnance Survey 25” to 1 mile map of 1926

Ordnance Survey 6” to 1 mile map of 1938

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Ordnance Survey 1:1250 map of 1963

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Appendix 1: Context List

Context List

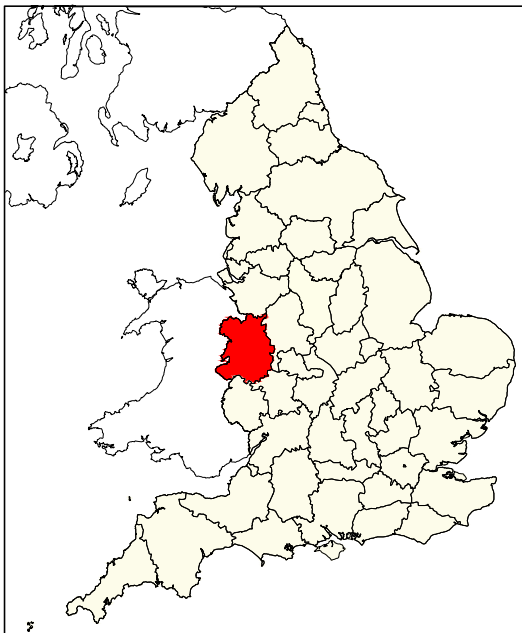
(01) Concrete Slab floor of maltings era building
(02) Redeposited clay layer beneath 01 and above demolition infill deposits and structural remains
(03) Demolition deposit (within and above chimney and flues)
(04) Demolition deposit (between chimney and privy tower)
(05) Demolition deposit (upper infill of privy tower structure)
*all of the above consisted of a loose rubble and degraded mortar/sandy deposit
(06) Chimney base (including stone plinth, concave flues and central shaft flue)
(07) Boiler ash (primary use deposit) central, circular shaft of chimney
(08) Fire brick wall constructed to the north of the chimney forming part of external flue (orientation east/west)
(09) Additional curving fire brick wall extending from 08 north beyond l.o.e. forming part of external flue leading from boilers (presumably a modification or later addition as it blocks off connection from the 3rd boiler)
(10) Fire brick wall constructed to the north of the chimney forming part of external flue with bull nose brick opening (damper)
(11) Sloping fire brick base of external northern flue
(12) Sloping fire brick base of external southern flue
(13) Handmade brick wall running east/west from western l.o.e in the northern part of the trench, encased by curving firebrick wall 10
(14) Fire brick wall, curvilinear northern side. Forming opposing bull-nose brick entrance / opening (damper) to 10
(15) Skin of fire-bricks added to western side of chimney
(16) Privy tower wall south
(17) Privy tower wall north
(18) Later wall constructed between 16 and 17
(19) Stone foundation of Main Mill
(20) In-fill brickwork of Main Mill foundation wall (modern looking)
(21) Original backfill around foundations of privy tower below 04 (redeposited clay with brick rubble)
(22) In-fill of brick between brick pier/buttress and base of Main Mill/spinning block with OPC bond (south)
(23) In-fill of brick between brick pier/buttress and base of Main Mill/spinning block with mortar bond(south)
(24) In-fill of brick between brick pier/buttress and base of Main Mill/spinning block with OPC bond(north)
(25) In-fill of brick between brick pier/buttress and base of Main Mill/spinning block with mortar bond(north)

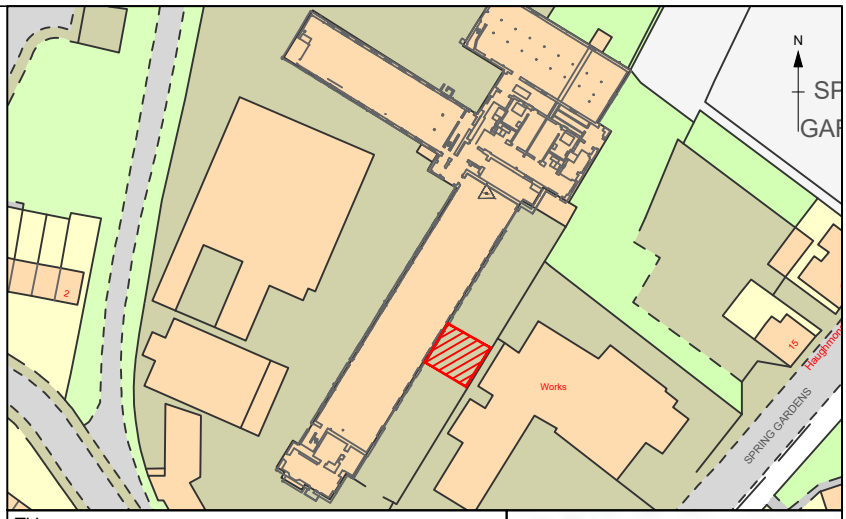
Appendix 2: Figures

Figure 1: Ditherington Flax Mill site location

Figure 2: Orthographic plan of chimney and privy tower excavation

Figure 3: Orthographic plan of chimney excavation overlain on extract of 1855 plan, with annotations on phasing of flues





Title:

Ditherington Flax Mill site location

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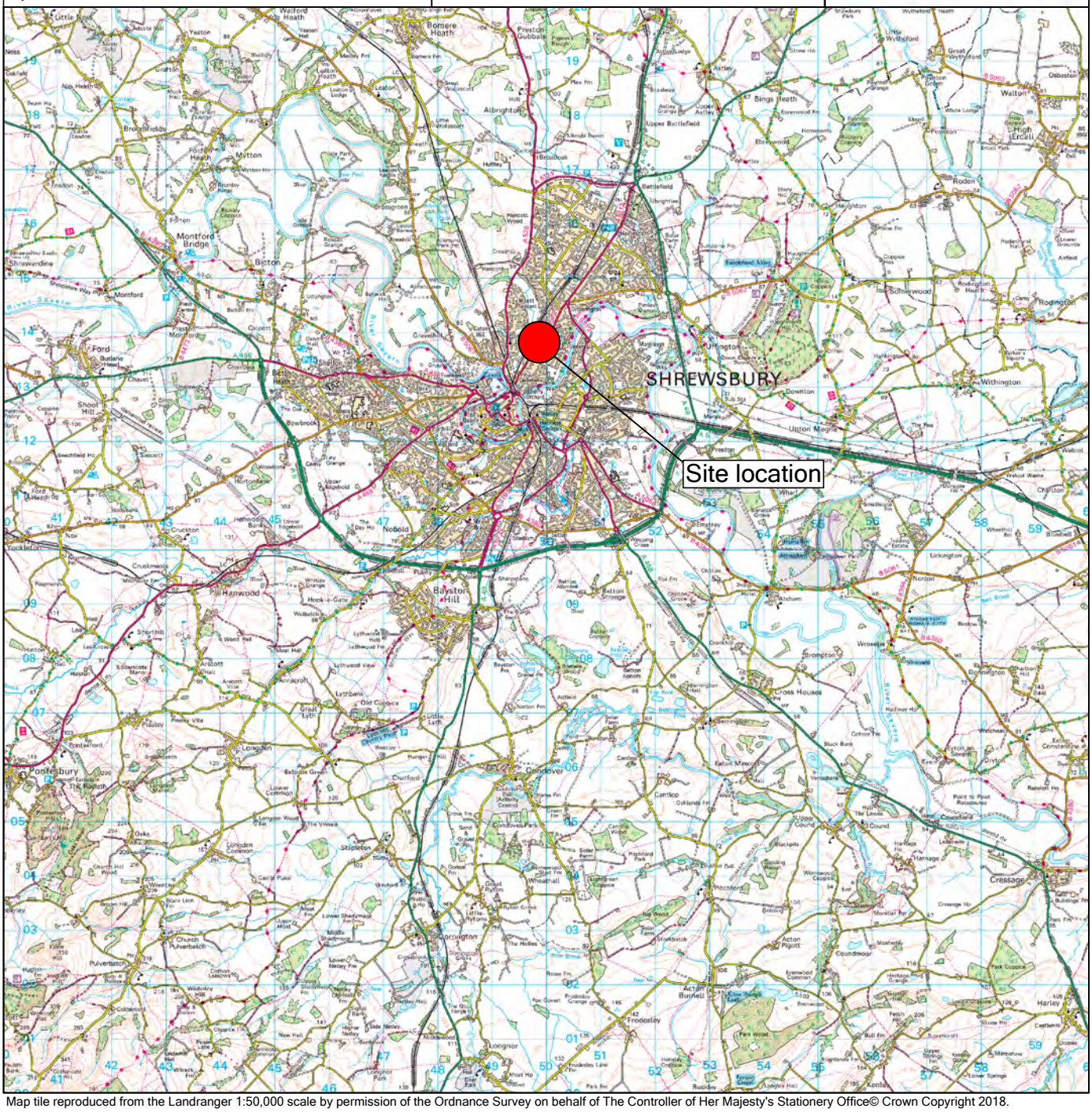

Salford Archaeology, Peel Building,The Crescent, Salford, M5 4WT

Title:

Orthophotographic plan of chimney and privy tower excavation

N

Key:

limit of excavation

001 context number

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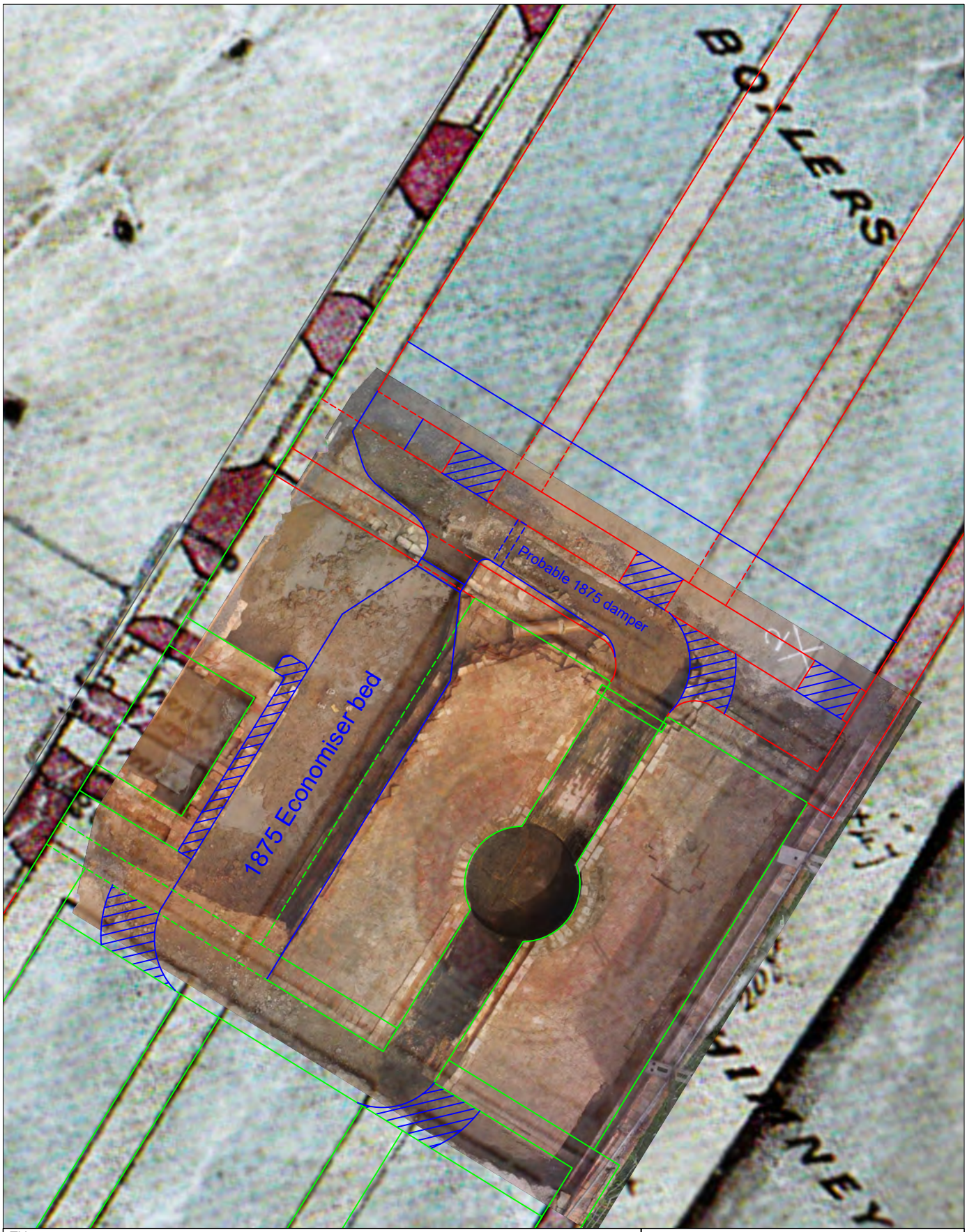
0 2 m

Scale at A4 1:50

Salford Archaeology, Peel Building,The Crescent, Salford, M5 4WT



Title:

Orthophotographic plan of chimney excavation overlain on extract of 1855 plan, with annotations on phasing of flues

N

SALFORD ARCHAEOLOGY

0 5 m

Scale at A4 1:75

Key:

- Fabric extant by 1841
- 1840-41 fabric, subsequently removed
- 1852-53 additions
- 1852-53 fabric, subsequently removed
- 1874-75 additions
- Blocking/rebuilding on 1874-5

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