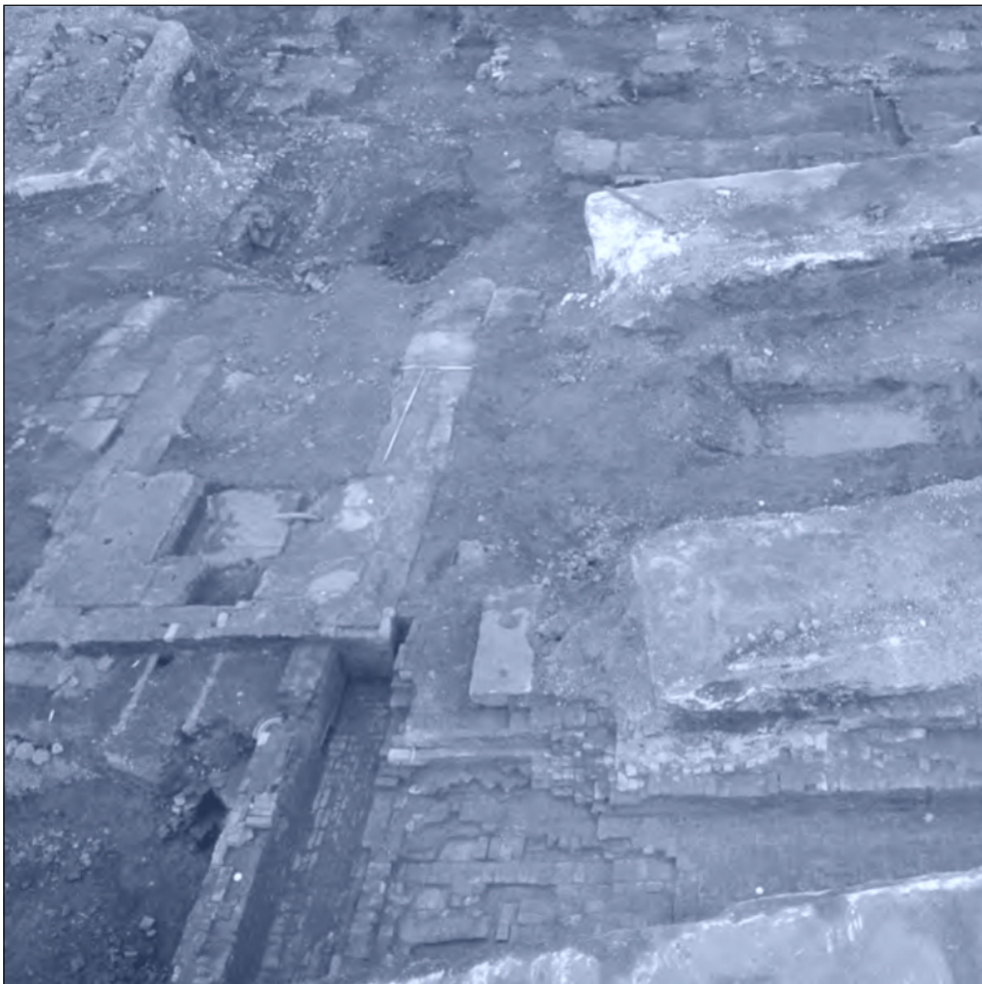




making sense of heritage

Kelham Rolling Mills, Sheffield An Archaeological Investigation

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KELHAM ROLLING MILLS, SHEFFIELD – AN ARCHAEOLOGICAL INVESTIGATION

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INTRODUCTION

Project background

A programme of archaeological fieldwork conducted by ARCUS (Archaeological and Research Consultancy at the University of Sheffield) examined the site of the former Kelham Rolling Mills at Alma Street, Sheffield prior to the redevelopment of the site for housing.

The ARCUS investigations comprised desktop study (ARCUS 2003), standing building recording (ARCUS 2007), and archaeological evaluation, excavation and watching brief during the redevelopment works, which included dredging of the Kelham Island goit (ARCUS 2009).

Geology, topography and urban character

The site (centred on NGR SK 353 881) is located within the Kelham Island Quarter of Sheffield (Figure 1), and lies between the former Greenups steelworks site (known as Kelham Riverside) to the east and Kelham Island Industrial Museum to the west. The River Don forms the northern boundary to the site and the Mill Sands (Kelham) goit flows beneath Alma Street immediately to the south. The subsurface geology of the site is mudstone beds of the Carboniferous 'Westphalian A' (Upper Coal Measures) (*British Geological Survey online viewer*).

The limits of the site lie within the Kelham Island Conservation Area formed by a clearly defined group of buildings and roads of historical industrial significance. Kelham Island is one of a few Industrial Conservation Areas in the country, alongside Nottingham's Lace Market, Birmingham's Jewellery Quarter and Bradford's Little Germany. Within the

Conservation Area the Green Lane Works (Grade II* listed) and the Brooklyn Works (Grade II listed) are both important industrial heritage sites and 'The Island' is steeped in industrial history dating back to the establishment of the Town Corn Mill in the 12th century. The area also housed one of Sheffield's last traditional hand-made scissor makers, Ernest Wright and Son Limited, until their relocation to premises closer to the city centre in 2011, the Smithfields Works of Samuel Staniforth, cutlery manufacturer, and most recently TurtonTyzack, manufacturer of steel edge tools (including the 4" WHS trowel).

Archaeological recording programme

Aims and objectives

The overall aim of the archaeological recording was to produce a coherent synthetic account of the industrial development of the site, specifically the rolling mills and firebrick works, correlating the recorded phases with historic maps and documentary evidence.

The specific aims of the building recording were to produce a detailed archaeological record of the historic structures within the proposed development area, and also produce a general photographic record of the area as a whole prior to demolition and development.

The evaluation, excavation and watching brief aimed primarily to record the remains of buildings associated with the former Kelham Rolling Mills and adjacent areas as shown on historic maps, and also establish whether any earlier features were present. More specifically the work aimed to determine the type of rolling taking place, either the primary rolling of wrought iron or the production of finished rail, girder or bar.

The overall objective was to place the site within the wider contextual framework of industrialisation within Sheffield and its region and consider this with regard to national developments during the various phases.

Methodology

Four trial trenches were excavated initially; these were followed by three mitigation excavation areas (Figure 2). Trench 1 and mitigation area A were targeted on structures

thought to be associated with the Kelham Island Firebricks Works dating from the early 1900s. Trench 2 and mitigation area B (which subsumed trench 2) lay within the former Kelham Rolling Mills, whilst Trench 3 was targeted on a cruciform building first depicted in 1771. Trench 4 and mitigation area C (which subsumed trench 4) targeted workshops located along the eastern edge of the site, just to the north-east of Prospect House.

Prospect House and standing structures at the south-western corner of the site were the subject of a building survey (ARCUS 2007).

DEVELOPMENT OF THE SITE

The history of the site is considered below, as far as possible, in chronological and spatial terms. Sections comprising early developments, the rolling mills, the Highway Yard, the firebrick works and Prospect House incorporate archaeological, cartographic and documentary evidence. Further information comes from the relatively small assemblage of finds, mainly pottery, details of which can be found in the archive reports.

1. Early developments

The earliest documented human activity within the vicinity of the site was the creation of Kelham Island. This was formed by the construction of a millrace (a 'goit') from the River Don at Kelham Weir in the north-west to Millsands and Lady's Bridge in the south-east to feed the town corn mill (the Town Mill) located at Millsands (see Figure 1). Described by Leader (1901, 365) as "one of the most ancient things in Sheffield", the construction of the goit is attributed to William de Lovetot, who was Lord of the manor of Hallamshire in the 12th century (Hey 2005). The majority of the Island appears to have remained as meadow or pasture up to the end of the 18th century.

Kelham Wheel (see Figure 2), a cutlers' grinding wheel attached to a grinding workshop leased by the town armourer, Kellam Homer, and his colleagues is first mentioned in 1604 (Ball *et al* 2006, 15). The earliest depiction of the Kelham Wheel, on Ralph Gosling's 1736 map of Sheffield, appears to show a single building straddling the main goit channel, with a

smaller subsidiary goit running along the northern side of the building. The remainder of the Island is predominantly meadow, including what appears to be a small allotment plot. Thomas Oughtibridge's 1737 (1745 edition) oblique pictorial representation shows this allotment to be an orchard and depicts a second building just to the north of the Kelham Wheel. It is possible that this may be the cruciform structure (see Figure 2) seen first, cartographically, on the 1771 Fairbank's map. A larger allotment plot and the buildings associated with the Town Mill are also depicted towards the southern end of the Island at Millsands.

By 1771 the area around Kelham Wheel had undergone a small amount of development. Fairbanks shows a further goit to the south of Kelham Wheel, feeding a Silk Mill which is documented as a 'Cotton Mill' by at least 1792 (Ball *et al* 2006) and cartographically by 1808; the remains of the Cotton Mill building were demolished in 1975. A cruciform-shaped building to the north of Kelham Wheel may be that depicted by Oughtibridge (see above).

By 1808 (Fairbank 1808) the land either side of the cruciform building had been further developed. Four buildings to the west appear to be surrounded by agricultural land, which extended to the north of the cruciform building. To the east, another four buildings are depicted which may be industrial in nature, the site then appearing to remain unchanged up to 1823. By 1822 (Smith 1822) however, the Union Grinding Wheel had been constructed further to the east. This was demolished in 1959, and the former Greenups factory was built on the Union Grinding Wheel site in the early 1960s.

From 1832 (Tayler 1832) onwards Kelham Island underwent a transformation. Many of the existing buildings were extended and modified alongside new buildings constructed on the site, as well as to the east and west. John Crowley's Iron Foundry was built to the west of the site in 1829 and continued in operation until the 1890s, as the Russell and Kelham Iron Works, and this subsequently became the site of Kelham Power Station, used to power the electric tram network for the city. These are the premises now occupied by the Kelham Island Museum.

By 1838 (Franks 1838), a rectangular building is depicted on the site of the Kelham Rolling Mills, to the west of the Union Wheel where a series of yards and associated structures is shown. These formed Smithfields Works, manufacturing cutlery for Samuel Stainforth. This site was gradually expanded until the 1950s, by which time the central part consisted of a large open yard for storing steel billets operated by Kelham Island Steel Works Ltd. This company was listed up to 1974 and the site was latterly under multiple ownerships, including TurtonTyzack Ltd.

2. Kelham Rolling Mills

The archaeological investigations targeted various aspects of the growth of the Kelham Rolling Mills. Trench 2 and area B (Figures 2 and 3) focused on the works dating from at least 1853, as depicted on the OS map, whilst trench 1 and area A (Figures 2 and 7) were located to examine the western expansion of the works by 1890 (as shown on the OS map). The standing building survey focused on the extant chimney and buildings located in the south-west part of the site.

1808–1838

Historic mapping (see above) shows that Kelham Island was probably largely pasture or meadow up to at least 1808, when the area is shown as divided into two separate plots, including allotments. Remnants of buried topsoil were located towards the eastern edge of area B and the western edge of trench 1 and area A. The buried soil contained pottery dating from the 18th to early 19th centuries. A single building located on the Island may first be evident on Oughtibridge's 1737 (1745 edition) pictorial view of Sheffield. However, the first and probably more accurate cartographic depiction is on the 1771 Fairbank's map of Sheffield, which shows a structure of cruciform plan. The building is still evident in 1853, within a group now represented as nine smaller units (Figure 2). Around this time the building appears to have been subsumed within the Kelham Rolling Mills works. The archaeological investigations of this area (trench 3 – Figure 2) uncovered a number of brick

and sandstone walls along with three machine bases and a possible chimney base. However, much disturbance of this area was apparent, probably as a result of the extension of the Kelham Rolling Mills in the late 19th and early 20th centuries, and there was little indication within the trench of the nature of the earlier activities being carried out in this part of the site.

By 1832 the Kelham Island Iron and Steel Works had been built on the land to the west of the site and the area to the east shows the Union Grinding Wheel's long building (Tayler 1832). A substantial wall 1088 forming the western boundary of the site (see Figures 2 and 7) was probably constructed between 1823 (Leather 1823) and 1832 and appears to form the eastern wall of the easternmost building of the Kelham Island Iron and Steel Works. The wall was built of un-frogged, handmade bricks bonded by a white lime mortar typical of the early 19th century. All of the walls to the east of this wall were built later and abutted it.

The Kelham Rolling Mills comprised a steel rolling mill and tilting forge, first listed in the 1839 Trade Directory as 'William Charles, Sons and Travis: Kelham Rolling Mills'. The earliest cartographic evidence of a building in this area is depicted on the map associated with White's 1838 *History and Directory of Sheffield* (Picture Sheffield: <http://www.picturesheffield.com/maps.php?file=029>). The building is represented as a single, small, rectangular structure located in the central northern part of the site, along the southern bank of the River Don. The building is surrounded to the west, south and east by a larger courtyard which probably encompassed some of the former fields depicted on the earlier maps. The three buildings shown in 1832 to the south of the courtyard are also present in 1838.

Careful examination of the alignments of the buildings shown on the historic maps suggests that the rolling stands and southern wall uncovered during the archaeological investigations may well have formed part of the original works shown on the 1838 map (White 1838). However, as the archaeological evidence matches more closely with the 1853 edition OS

map (Figure 2) then the remains can only confidently be assigned to that phase of the works' development.

1838–1853

The excavations revealed traces of the southern wall (A) of the rolling mill building running along the south side of area B (Figure 3). The central portion of the wall contained a large gap to accommodate a group of three Lancashire Boilers, which are evident on the 1853 OS map, annotated as 'Boilers' and 'Chimney' (Figure 2). The excavations exposed the base for probably the central boiler and part of the chimney (Figure 3; Plate 1), evidence for the northern boiler having been destroyed by the concrete base. The boiler base (B) consisted of a sub-rectangular arrangement of firebricks, measuring 8.25m by 2.55m, and aligned east-west. The surviving structure consisted of the basal, brick-built secondary flue and part of the truncated northern tertiary flue. The tertiary flue was raised slightly above the base to allow hot air to pass along the sides of the boiler, and part of the boiler and flue bricks were encased in an external red brick structure which was still evident at the north-west corner and western end.

Beyond the western end of the boiler base was a narrow, rectangular, recess or slot with a brick floor (C). The recess was formed by the western wall of the stoking hole of the boiler(s) and a further wall to the west, and was around 0.75m deep with several drains and iron pipes extending from it. It is likely that the recess was covered with cast iron plates to allow the stoking of the boiler(s) from the western end. A large pipe entered the recess at the north-west corner, continuing further to the south-west within a brick culvert. It is probable that this pipework fed cold water into the boiler system and the culvert appeared to be leading from one of the buildings shown on the 1853 OS map fronting the road on the south side of the site (see Discussion below).

At the eastern end, the boiler base was linked to a partially exposed octagonal chimney (D) (Plate 1), and the layout depicted on the 1853 OS map indicates that the chimney served all three boilers shown on the map. A sandstone floor (E) set around the chimney to the north-

east formed part of a yard surface which extended into the open part of the south side of the building and allowed access (Figure 3).

The boilers provided steam via a system of pipes to drive machinery within the factory. Much of the floor plan survived, but a large portion in the vicinity of the area occupied by the rollers had been destroyed by the later concrete foundations. Incorporated within the southern wall of the building was a substantial, U-shaped, brick and sandstone wall, with an associated group of sandstone blocks (F) (Figure 3; Plate 1). The central blocks contained a shallow recess into which three large bolts, various screw threads and plates were set to hold down machinery, probably a steam engine for driving the rollers. To the south of the recess was the location of a fly-wheel, indicated by a semi-circular hollow in the stone blocks, which would have served a rotary drive shaft on a north-south axis. A deep void at the northern end of the U-shaped wall (Figure 3) was probably the location of another fly-wheel. This may have been associated with a rotary drive shaft along an east-west axis, in line with the axis of the rolling stands to the east, and linked by gearing to the north-south drive shaft.

The second drive shaft extended to the eastern end of the rolling stands (I) (Figure 3). The drive shaft housing (G), probably with a further fly-wheel (with a diameter of at least 0.65m, indicated by a semi-circular hollow), was anchored to a setting of sandstone blocks (Plate 2). Several iron pins and slots were probably associated with securing the housing and perhaps other machinery linked to the rolls. A drain cut into the blocks at the east end and lined with brick (see water flow on Figure 3) indicates that the rolls were water-cooled when in operation. The drain running from this area fed into a large stone-lined drain (K) flowing alongside the rolling stands (see water flow on Figure 3), confirming their contemporaneity. A steam engine which provided additional power to the east-west drive shaft, via a second north-south drive shaft, could have been located in (or above) a cellared structure (H) to the south of the drive shaft housing (G) (Figure 3). The cellar walls were constructed from handmade red bricks and the floor was sandstone flagged; iron pins in the eastern, buttressed wall were presumably associated with machinery. It is probable that a large iron

pipe overlying a short section of firebrick at the south-western corner of the cellar fed steam from the Lancashire Boilers to the engine, located in or over the cellar. A drain leading from close to the north-west corner fed into a larger drain (R) which ran north-south below the rolls and into the major east-west drain (K) to the north (see water flow on Figure 3)

The principal surviving feature of the Kelham Rolling Mills was the rolling stands themselves. Whilst it is possible that these rollers were located in the first building noted from 1838, they appear to form an integral part of the later, 1853 design. Although the upper portions of the stands were missing, and part of the area had been destroyed by more recent concrete foundations, a surprising amount of structural detail can be gained from the surviving footings. The stands (I) were aligned east-west (Plate 3) and consisted of a series of sandstone blocks (Figure 3), arranged to form the supports for four individual sets of rollers (i–iv) (Figure 3); an arrangement of ‘One row of rolls of four pairs of rollers with driving gear’ was noted in the 1864 flood claim (Appendix 1). It would appear that rollers i and ii were linked by the same group of foundation blocks and probably worked in tandem. A short length of brick wall separated rollers ii and iii, whilst rollers iii and iv were separated by a square recess (J), which appeared to be part of a drain, with openings observed running to the north and south (Figure 3).

Significantly, the sandstone support for stand iv was associated with a 0.05m thick deposit of ferrous material that probably represents ‘mill scale’, which covered the majority of the length of the support (Figure 3). A build-up of this material was also noted at the eastern end of stand iii. Stand ii contained no such deposit and only a small patch was located on stand i. The build-up of this material on the stands is indicative of the processes taking place within the factory and its distribution hints at further sub-divisions of use between the rolling stands (see Discussion below).

Grooves or channels along the centre of each rolling stand (Figure 3) were related to water management and indicate the direction of operation of the rollers. They show that the iron was fed through the rollers from north to south and from south to north, either side of the

roller alignment. Gearing on the rolling mechanism would have enabled the rotation of the rollers, one above the other in each pair, to have been reversed, allowing material to be passed from one side and back through without reversing the direction of the primary drive shaft.

The presence of water collection channels (Figure 3) is important in understanding the type of rolling taking place at the factory (see Discussion below). A small brick-lined drain extended along stand i before turning towards the north and appearing to continue beneath one of the furnaces (see below), towards the River Don. The central channels in rolling stands ii and iii fed into a large drain (K) located to the north of the rolling stands. As noted above, stands iii and iv were separated by a drain pit (J), and a further deep, brick-lined drain (L) was located beyond the eastern end of the rolling stands, with another (R) parallel to it and extending from the west side of structure H. Two parallel stone-capped drains were also recorded running north to the River Don from the east end of the main drain (K), which itself turned and probably emptied into the river. Both stone-capped drains may have been continuations of drains L and R respectively, which emptied into drain K from the south, hinting at the possibility of more than one phase of drain. Overall, it is clear from the excavations that water management formed an integral part of the design of the factory and the rolling structures themselves.

Along the northern edge of the site, parallel to the rolling stands, was a series of structures which were only partially revealed. Structures M and N (Figure 3) comprised alternating red brick, firebrick and sandstone surfaces which displayed a high level of heat discolouration. To the east of these was a series of substantial sandstone and firebrick features (O), similarly heat-affected, probably representing the remains of several furnaces related to the re-heating of iron prior to the rolling process. A further furnace is indicated by a flue system (P) at the western end of area B (Figure 3). The flue extended beyond the western limit of excavation to the west, and broadly aligned with the three small square structures, probably chimneys, shown on the 1853 map outside the western wall of the building. The flue system

was incorporated in a sandstone surface (Q) that would have been inside the western end of the building.

The expansion of the premises to the west was limited by the large wall 1088 (see Figures 2 and 7), which was probably constructed between 1823 and 1832 (see above). The excavations in trench 1 and area A found very little surviving evidence of the four buildings and passageway walling on the western side of the rolling mills (see below), as depicted on the 1853 OS map (Figure 2).

1853–1890

By 1853 'John Charles's Kelham Rolling Mills Company Ltd' is listed in trade directories as occupying the rolling mills. Between 1853 and 1890 the factory expanded to the west, and the buried topsoil seen in various places was overlain by tips of industrial waste including clinker as a levelling layer. The preparation of areas with industrial waste prior to construction was a common occurrence during this period, as the clinker provided a highly compact and porous layer for foundations and flooring.

The former buildings at the western end of the site appear to have been subsumed within a single L-shaped structure by the end of this period (or are depicted as such), the arrangement appearing to go unchanged until at least 1903. In the south-western corner of the site a single chimney is shown, extending above the structure. The building survey examined the group of then standing buildings (G1–7) in this area (see Figures 1 and 2), and revealed a complex development that included a rectangular building (G4; Figures 4 and 5) containing three high arched windows 2m above floor level facing the street (Plate 4). Structural evidence suggests that the octagonal chimney may have been added at a later date to the original building. It is uncertain what the function of this building was, but the chimney may have vented one or more furnaces that were used to heat or otherwise treat iron or steel billets prior to them being sent for rolling. The chimney is still standing today and forms part of a commercial premises.

A culvert or flue (103/1050) uncovered in trench 1 and area A (see Figures 2 and 7) probably relates to the use of the octagonal chimney, and at the northern end turned to the north-west where it connected to another, partially revealed firebrick-lined flue or culvert. It seems likely that these developments formed part of the factory extensions undertaken between 1853 and 1890.

1890–1929

The Lancashire Boilers are still evident on later maps of the area, up to at least 1903. However, by 1919, the Kelham Island Brick Works are listed in trade directories as occupiers of the site, and the rolling mills had ceased operation. The cartographic evidence from 1930 shows that the majority of earlier buildings on the site had been demolished, apart from the range at the west of the site which was taken over by the Kelham Firebrick Company.

It was during this period, following the demolition of the central building housing the rolling mills, that the area was levelled and used temporarily as a steel billet storage yard, the surface of which was laid with sandstone setts. One of the finds recovered from the demolition deposits was a fragment of railway rail, potentially a rare example of an early bulk steel rail. The results of the metallographic analysis (Plate 5) suggest that the rail was produced by one of the earlier types of bulk steelmaking processes, and then hot rolled. The hardness and dimensions of the rail indicate that it had probably been manufactured for a 'light' railway or tramway application. However, there is not enough evidence to confirm whether the rail had been produced at the former rolling mill where it was found, or was in use there, or was scrap stock brought in for re-rolling.

3. Highway Yard

The Highway Yard area, part of which belonged to the Kelham Rolling Mills complex, can effectively be split into two separate (north and south) halves. The northern half appears from the earliest cartographic and pictorial evidence to have been under pasture until around 1808, when the area seems to have been enclosed as agricultural land, including probable

allotments, to the north-east of the cruciform building. Other than this, the land still appears to be clear on White's 1838 map of the area. By 1853, however, the area is described as 'Highway Yard' (Figure 2) and was bounded by substantial walls (Plate 6) on all but the western side, where it was connected with the main Kelham Rolling Mills complex. Two adjoining buildings abutted the northern boundary wall and a weighing machine was centrally positioned at the eastern end of the rolling mill building. The yard was presumably used to store rolled products from the mills prior to dispatch.

The southern half of the area appears to have been developed by at least 1808 when four separate structures are shown on the Fairbanks map of Sheffield. One small, square structure lay just to the east of the cruciform building and two long, narrow, rectangular north-south aligned buildings and an inverted T-shaped building were constructed in the south-east corner of the site. By 1853 the number of buildings had increased, further emphasising the separation between the two halves of the Highway Yard area (Figure 2). It is likely that the most northerly of the rectangular buildings depicted in 1808 was still extant, now with a small boiler located at the external north-western corner. The 1896 Goad Fire Insurance plan indicates that this eastern range included a northern two-storey building with a 4-horsepower steam engine, and a one-storey 'Smithy' adjoining to the south. Presumably the same smithy was mentioned as 'No.1 smiths shop' in the compensation claim for the flood damage that affected the Rolling Mills in March 1864. Abutting the west wall of the two-storey building was a structure for housing a small Lancashire Boiler, most likely providing power to the steam engine located in the building. The archaeological investigations (trench 4 and area C) targeted this complex of buildings, dating from before 1853 (Figure 2), and confirmed the basic arrangement as well as exposing the layout within that to the north.

The excavations revealed the brick walls of the more northerly building (A) (Figure 6), which measured 13.75m by 6.25m (Plate 7). The walls were constructed from red handmade bricks on a sandstone foundation, and at least nine courses of the wall had survived. Some repair was evident within the walling and there was the remains of an internal partition; no

external doorway was located, though there was probably an entrance to the adjoining smithy midway along the southern wall.

Within building A was an enigmatic, red handmade brick, lime-mortared, semi-circular structure (B) containing a core of firebricks (Figure 6; Plate 8). This structure was built within the south-eastern corner of the building, with a short flue which extended to the corner of the building. The bricks of the semi-circular structure abutted the building's brickwork suggesting that it was a later addition, possibly contemporary with the Lancashire Boiler (see below). The exact function of structure B remains unclear; however, the presence of a substantial firebrick feature with a flue leading directly from the probable firing area suggests the presence of a boiler. The possible cylindrical nature of this installation and its proximity to the smithy, directly to the south, may indicate a vertical boiler and blowing engine. Within this part of structure B was a small, L-shaped room with a brick floor (D) which was keyed into the semi-circular structure. It is possible that this room provided access to structure B, possibly to stoke the boiler above. The northern part (C) of the L-shaped structure (D) could have formed a small recess to house the fly-wheel which may have driven an air pumping cylinder located above the boiler.

Along the western wall of building A was a 12.5m long, 2.5m wide red brick 'annexe' containing a firebrick flue base with slightly raised side flues (E) (Figure 6). A small, square chimney (F) lay at the northern end of this structure and the southern end was delineated by a cross strut of cast iron (G). The external walls of the annexe continued further to the south, forming a stoking area with a brick-floored room (H), possibly for the storage of coke. The annexe abutted the wall of the rectangular building (A), indicating that it was a later addition. Structure E aligned approximately with the boiler shown on the 1853 OS map (Figure 2), and is interpreted as a boiler house for a Lancashire Boiler producing steam power for use in the adjacent building. However, what machinery the boiler was providing power to is unclear. Remnants of sandstone flooring and sandstone and red brick structures towards the north-

east corner were uncovered, but it was clear the building had suffered extensive disturbance from later drains and demolition activities.

To the south of building A was a sequence of substantial sandstone blocks (J) and a stone-capped culvert (K) which are thought to be the remains of the smithy mentioned in the 1896 Goad Fire Insurance document. It may be that the two buildings shared a functional link, and the presence of a small, possible air blower in building A could have provided air for a line of hearths located above the sandstone blocks (J) along the northern wall of the smithy.

Maps show that by 1903 the area was gradually becoming one continuous yard, linking the northern and southern halves of the Highway Yard, with a single line of buildings along the eastern boundary.

A deposit in the vicinity of building A produced a single bowl (almost complete) from a Pratt ware pipe produced c. 1790-1830 (source unknown). The bowl in the form of a duck head (Figure 8) is part of an elaborately decorated and glazed earthenware pipe, and is possibly the first fragment of such a pipe to be recovered from an archaeological context. Although pipes of this type could be smoked, they are more likely to have been produced as one-off novelties or for display.

The Kelham Rolling Mills were demolished before 1930, when the OS map shows a single, wide, warehouse building along the eastern side of the Highway Yard, with three separate buildings forming a quadrangle at the northern end. The standing building survey confirmed that these buildings in the Highway Yard had been demolished, and only the eastern and northern boundary walls survived (see Plate 6), dating from at least as early as 1853.

4. Prospect House

Additions made in 1863 to the 1850 OS map show that part of the goit to the east of Kelham Wheel had been culverted to allow for the construction of Alma Street. This change to the goit left a small triangular plot to the south of the Highway Yard. The 1863 map shows no

building in this plot. The standing building survey confirmed that the construction of Prospect House post-dated the eastern boundary wall of the Highway Yard and the buildings that had used that wall as their eastern wall.

The first evidence for Prospect House comes from the 1890 OS map of the area, which shows the building straddling the goit and fronting Alma Street. The building was constructed on a large brick arch that spanned the goit flowing beneath the street (Plate 9), and no changes to the external footprint of the building appears to have occurred after the time of its construction. Little evidence for the early use of the rooms and building survived to confidently interpret its original function. However, a blocked 'taking-in door' on the first floor (with surviving threshold directly above a ground floor window lintel; Plate 10), and low exposed first floor roof trusses with low window heights relative to the flooring suggest that the building was never intended for domestic or office use, and it is more likely to have been a small warehouse or store connected to the rolling mill. Minor alterations to the internal structure of the building and the windows in the 20th century indicate some re-ordering of the premises took place after the closure of the rolling mill. Most recently, the building was used as the offices for Samuel Stainforths and their Smithfield's Cutlery Works and called 'Prospect House'.

5. Kelham Island Firebrick Works

The first mention of the Kelham Island Brickworks is in 1919 (White's Directory), though a photograph said to date to 1914 shows 'Kelham Island Firebrick Works' in the background (see Plate 13). Initially trading as 'Brick Sheffield' and later as 'Frank Russell Fire Brick Manufacturer (General Refractories Co. Ltd)', the works specialised in 'all kinds of refractory and furnace materials'. 'General Refractories Co Ltd: fire bricks works' were still listed as the occupiers in 1941. They were recorded as a Worksop company, registered in 1900, with factories in Ambergate, Bawtry, Kings Lynn, Middlesbrough and Worksop.

The first cartographic evidence of the works, from 1930, shows the former rolling mill complex as an empty, demolished area and several structures to the west, some of them new. In the area of the brickworks were three buildings fronting the road (buildings G1–4), surviving from the Kelham Rolling Mills period of operation, with a small rectangular building slightly to the north (building G5) and a larger square building towards the back of the plot (buildings G6 and G7). The extant buildings were subject to a standing building survey and archaeological investigations targeted the northern building G6–7 (trench 1) and the central building G5 (area A) following demolition.

Several earlier features, principally a brick culvert or flue uncovered in trench 1 and area A (see above), were truncated by the construction of the brickworks. The erection of the new buildings associated with the Kelham Island Brickworks probably began sometime prior to Frank Russell's takeover in 1919. It is likely that the existing southern range of buildings (G1–4) remained in use during this period and the first floor may have been adapted for offices. The western side of the building remained open to the roof and was dominated by the large octagonal chimney (see Figures 4 and 5). The lower part of the chimney had been cement-rendered to match the new interior of the building in which any original openings may have masked. However, an opening in the south-east face may have connected to the line of the culverts or flues dating to the rolling mills phase of use of the chimney.

The archaeological evidence suggests that the chimney was adapted to vent smoke which entered from its northern side. A flue (A) was uncovered in the south-western corner of the excavation which extended to the north, before returning to the east, towards the sub-surface brick kiln features (Figure 7).

The sub-surface features of the brick kilns comprised two substantial L-shaped structures (B and C) which mirrored each other (Figure 7). The flue structures measured over 8m east-west in length with 3m long returns which fed into the eastern end of chimney flue A (Plate 11). The flues were constructed predominantly from firebricks and measured 1m deep with a vaulted roof extending from the vertical walls. At the western end of the flues were two sets

of four transverse slots (D and E) built along the top of the flue structure. It is likely that the location of these slots indicates the position of the down-draught vents extending from the brick kiln drying room above. Any evidence of the brick kiln structures appears to have been removed by the time the building survey was undertaken (ARCUS 2007) and the concrete floor containing fixing bolts was presumably connected to its use after the brick kiln had gone out of use. Original windows present on the outer walls of the building (Plate 12) suggest that the brick kiln tunnel or drying room was a separate structure located within this building and a large roller shutter door at the eastern end may have been an original feature allowing wide loads of bricks to be brought inside the building prior to being put into the drying room/tunnel.

Aerial photographs taken just after World War II show that the area of the former rolling mill was probably used as a stock yard for the brickworks and this appears to have continued until at least 1955, based on OS map evidence.

DISCUSSION

The initial purpose of the goit on the west side of Kelham Island was to supply water to drive the 12th century Town Corn Mill at Millsands. The length of the goit may have been dictated by the sinuous course of the River Don in this area, the creation of the goit and Kelham Weir providing a straighter route to the mill and increasing the head of water. The remainder of the Island was probably given over mainly to pastoral use until the construction of the Kelham Island Wheel, by 1604, known from documentary sources to have been a cutler's wheel.

The presence of the Kelham Wheel and the subsidiary goits was fundamental in determining the location of subsequent industry on the Island. By 1771 the area to the north of the Wheel contained a building of cruciform plan (partly exposed in trench 3), but of unknown function, which later became subsumed within the Kelham Rolling Mills complex, but was demolished by 1890. To the south of the Kelham Wheel another goit was created to power a short-lived silk mill.

Within the space of less than 40 years, between 1770 and 1807, further buildings on the west side of the site appear to have been associated with agricultural use. However, four buildings on the east side may have had an industrial function. Excavation on the more northerly of these buildings (in area C) – possibly in existence before 1808 – indicated that the building required steam power, probably initially provided by a Cornish Boiler. However, the exact function of the building could not be determined, though the evidence suggests that it may later have contained another boiler and perhaps an air pumping cylinder.

Within another 25 years, by 1832, two major factories had been built on either side of the site. On the west side was the Kelham Island Iron and Steel Works and to the east was the Union Grinding Wheel. It is likely that the establishment of these industries created the ideal location for a rolling mill, the earliest known examples elsewhere in use by the end of the 17th century (Jones 2006). As well as the new factories, housing began to grow during the early 19th century, concentrated off Alma Street immediately to the south of Kelham Island, providing accommodation for workers as industrialization of the area increased.

The earliest map of the Kelham Rolling Mill, from 1838, shows a small rectangular building in approximately the same location as that shown on the later and more accurate 1853 OS map. The factory was first listed in the 1839 Trade Directory as 'William Charles, Sons and Travis: Kelham Rolling Mills'.

One of the key aims of the archaeological investigation was to determine the type of rolling taking place within the Kelham Rolling Mills. For example, was the rolling mechanism a forge train for primary rolling of wrought iron immediately after shingling (hammering to remove impurities in the metal), or was the rolling mill connected to the reheating of purer material to produce end products in the form of rail, girder or finished rolled bar? The trade directories from around the time list the premises as tilers, forgers and rollers, suggesting perhaps that the mills were rolling wrought iron brought in from other iron and steel works. Furthermore, no evidence for puddling furnaces or large hammers was uncovered during the excavations. The process began with the production of pig iron formed in blast furnaces, followed by initial

hammering (or shingling) using a helve or steam hammer to expel impurities. The billets produced could then be puddled or later converted into steel before rolling, or sent straight to the rolling mill. During subsequent rolling, the first roll involved roughing down, removing further impurities in the metal, and then the second roll further refining and finishing. The metal could be rolled into a finished product at the same mill or sold to another factory for this process to be completed. It was essential that the rollers connected with a forge train were kept cool by constantly pouring water onto them (Jones 2006), and the channels in the base of the rolling stands, together with the profusion of drains indicate that extensive water management was required within the factory. This evidence suggests that these rollers were used as primary rollers and, furthermore, the deposits found associated with them, consisting of corroded iron scale, appear to be the grey-coloured mill scale that resulted from hot (or forge) rolling (Jones 2006).

The most easterly rolling stand (iv) contained a 0.05m thick deposit of corroded ferrous material, probably mill scale formed during the initial roughing down of the wrought iron. A smaller but heavily concentrated deposit of the same material was present at the eastern end of rolling stand iii. In contrast, stand ii contained no such material and only a small patch was detected at stand i. Whether this distribution indicates that each roller was given over to a specific task within the factory remains unknown. However, it is possible that the initial roughing down of the iron took place using stand iv at the eastern end of the rolling block. The material could then have been re-heated in the furnaces along the northern side of the factory before being passed through rolling stand iii. The lack, or paucity, of this material on stands i and ii could indicate that the western end of the rolling machine was preserved for rolling iron containing less impurities into finished products, though the presence of some material on stand i suggests that the rolls may not have been solely used for any one particular function.

Some of the pipework extending into the recess on the western side of the Lancashire Boiler bases would have fed the boilers with water, generating the steam power to drive the rollers

and other machinery. The incoming pipework was encased in a large brick culvert which lay directly north-east of a group of buildings and a 'pump' shown on the west side of the entrance to the rolling mills complex on the 1853 OS map. It is possible that some of these buildings were involved in the pumping and filtration of water from the goit before it was piped to the boilers.

Rolling mill process flow

On the basis of the evidence recorded, the following basic sequence can be suggested:

- 1: Raw materials brought into the rolling mills complex through the entrance in the south side;
- 2: Iron heated in furnaces on the northern side of the factory (perhaps at some point after 1855 following initial heating or treatment in a furnace in the south-west corner of the complex;
- 3: Rolled material, possibly starting with 'roughed down' iron at the eastern end and progressing to more refined material or finished products at the western end.
- 4: Finished products probably stored in Highway Yard prior to transport.

Alongside this, the production of steam power involved:

- A: Water extracted from the goit and probably filtered prior to pumping to the Lancashire Boilers;
- B: Steam fed to at least two steam engines which powered each end of the rolling stands (a secondary water feed cooled the rollers);
- C: The waste water fed through a complex of drains towards the northern end of the factory before being discharged into the River Don.

The exact function of the building at the south-east corner of the site that was the focus of the excavation in area C remains unclear. It was certainly in use in 1853, when a small, possible Cornish Boiler (this type of boiler first attributed to Richard Trevithick in 1803) is

indicated (on the OS map) at its north-western corner. By 1853, however, the building appears to be separated from the Kelham Rolling Mills by the wall dividing the area occupied by the building from the Highway Yard to the north. It is possible, therefore, that the building was not connected to the rolling mill operation at this time. The Great Sheffield Flood of March 1864 caused widespread damage and the existing boiler was almost certainly destroyed, but the resultant insurance claim (No. 4525) probably allowed it to be replaced by a larger, more modern and efficient Lancashire Boiler (first patented in 1844 by William Fairburn and John Hetherington).

There is little evidence within the building at this time to reflect the machinery requiring the power, though the substantial firebrick feature in the south-east corner with a flue leading directly from the probable firing area indicates the probable presence of a boiler and perhaps an air pumping cylinder. This could have provided air to hearths in the smithy building to the south. The 1896 Goad Fire Insurance plan indicates that the eastern range included a northern two-storey building with a 4-horsepower steam engine, and a single storey 'Smithy' adjoining to the south. Presumably the same smithy was mentioned as 'No.1 smiths shop' in the compensation claim for the flood damage that affected the Rolling Mills in 1864. The 1890 OS map of the area indicates that by then the range had become part of the Rolling Mills, and the wall dividing the former Highway Yard from the southern plot had been removed, thus increasing the storage space for stock and finished products, probably reflecting increased output as the Rolling Mill complex expanded.

The expansion of the rolling mills also encompassed the western side of the site. By 1853 it is probable that the former agricultural buildings had either been demolished or, less likely, been converted for industrial use. The archaeological evidence, however, cannot resolve this and the earliest structural evidence comes from the 1853–1890 period, by the end of which time the area is shown on maps as a single structure. The standing building survey suggests that this depiction disguised several individual buildings. The large octagonal chimney and system of associated brick flues is suggestive that this part of the rolling mill complex was

involved in the heating of iron in a furnace prior to rolling and reheating in the central northern part of the works.

The Kelham Rolling Mills complex was probably demolished prior to the site being taken over by The Kelham Island Brick Company in 1919, but a photograph said to be from 1914 shows the elephant 'Lizzie Ward' (well known in Sheffield) and a stockpile of iron or steel billets with 'Kelham Island Firebrick Works' in the background (Plate 13). The majority of the central, northern and eastern buildings were demolished, the eastern buildings replaced by a large warehouse and the central part of the site used to store finished brick and furnace products. The building fronting the street appears to have continued in use as offices and the large octagonal chimney was re-built to serve the newly built brick kilns just to the north of the offices.

The brick kiln, of probable down-draught type, was constructed within a purpose-built structure (G5) with windows and a wide entrance to the east. At the western end of the flues were two sets of four transverse slots built along the top of the flue structure, these slots indicating the position of the down-draught vents bringing hot air from the furnace via the brick kiln drying chamber above. Although no evidence of a furnace was found, it is probable that this lay close to the drying chamber, at or above ground level. From the kiln, exhaust gases passed through the series of flues and then into the octagonal chimney located at the south-western corner of the site.

After World War II the area of the former rolling mill site was used as a stock yard for the brickworks, but following closure of the brickworks the site came under multiple ownership for a number of years. An aerial photograph from 1961 shows the former stock yard mostly occupied by two large sheds extending across the northern and southern halves of the site with the former brickworks warehouse to the east still extant.

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The archive has been deposited at Museums Sheffield: Weston Park Museum under Accession Number SHEFM 2006.215.

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APPENDIX 1. Details listed in Sheffield Flood Compensation Claim No. 4525

(appendix): Kelham Rolling Mills

- 40HP condensing steam engine to drive two trains of rolls, fly-wheel and shaft and crane
- 25HP condensing steam engine to drive 10 train rolls
- 60HP condensing engine to drive rolls
- 4 weighing machines
- 4 heating furnaces in the old part of the Rolling Mill
- 6 double furnaces on the lower side of the Rolling Mill
- 3 large central heating furnaces
- 3 steam boilers in the Rolling Mill
- 3 steam boilers in the yard
- Flues
- Cranes
- Steam boiler in the forge
- Steam boiler outside turning shop
- Taking up and relaying stone and iron floors
- Repairs to 690 feet of underground flues
- Cleaning and repairing 360 feet of drains

Figures

- Figure 1 Site location plan
- Figure 2 Trench and area excavation locations shown in relation to structures depicted on the 1853 Ordnance Survey map
- Figure 3 Area B plan, showing details of the rolling mill stands
- Figure 4 Section/elevation of Building G and octagonal chimney
- Figure 5 Floor plan of Building G
- Figure 6 Area C plan
- Figure 7 Area A plan
- Figure 8 Pratt ware tobacco-pipe bowl, produced c. 1790–1830

Plates

- Plate 1 Lancashire boiler base and part of interior of rolling mills, with modern concrete intrusions (area B). From south; scales = 1m and 2m (© University of Sheffield. Reproduced by permission)
- Plate 2 Structure G – drive shaft housing and fly-wheel location (area B). From east; scales = 2m (© University of Sheffield. Reproduced by permission)
- Plate 3 Rolling stands i – iv and associated drains (area B). From south; scales = 1m and 2m (© University of Sheffield. Reproduced by permission)
- Plate 4 Building G4 – street frontage (© University of Sheffield. Reproduced by permission)

- Plate 5 Metallographic section of rail showing generally uniform microstructure of pearlite and ferrite
- Plate 6 Highway Yard eastern wall (© University of Sheffield. Reproduced by permission)
- Plate 7 Building A with boiler 'annexe' on west side (area C). Scales = 1m and 2m (© University of Sheffield. Reproduced by permission)
- Plate 8 Building A – structures B, C and D in south-west corner (area C). Scales = 1m and 2m (© University of Sheffield. Reproduced by permission)
- Plate 9 Prospect House – east elevation over the goit (© University of Sheffield. Reproduced by permission)
- Plate 10 Prospect House – south elevation; note first floor central window replacing earlier 'taking in door' (© University of Sheffield. Reproduced by permission)
- Plate 11 Brick kiln (and earlier) flues (area A). From south (© University of Sheffield. Reproduced by permission)
- Plate 12 Brick kiln building, with octagonal chimney (building G4) to rear. From north-east (© University of Sheffield. Reproduced by permission)
- Plate 13 'Lizzie Ward' working at the rolling mills on Kelham Island, apparently in 1914, with Kelham Island Firebrick Works in the background (Sheffield Archives and Local Studies Library ref. s00069. © Sheffield City Council)

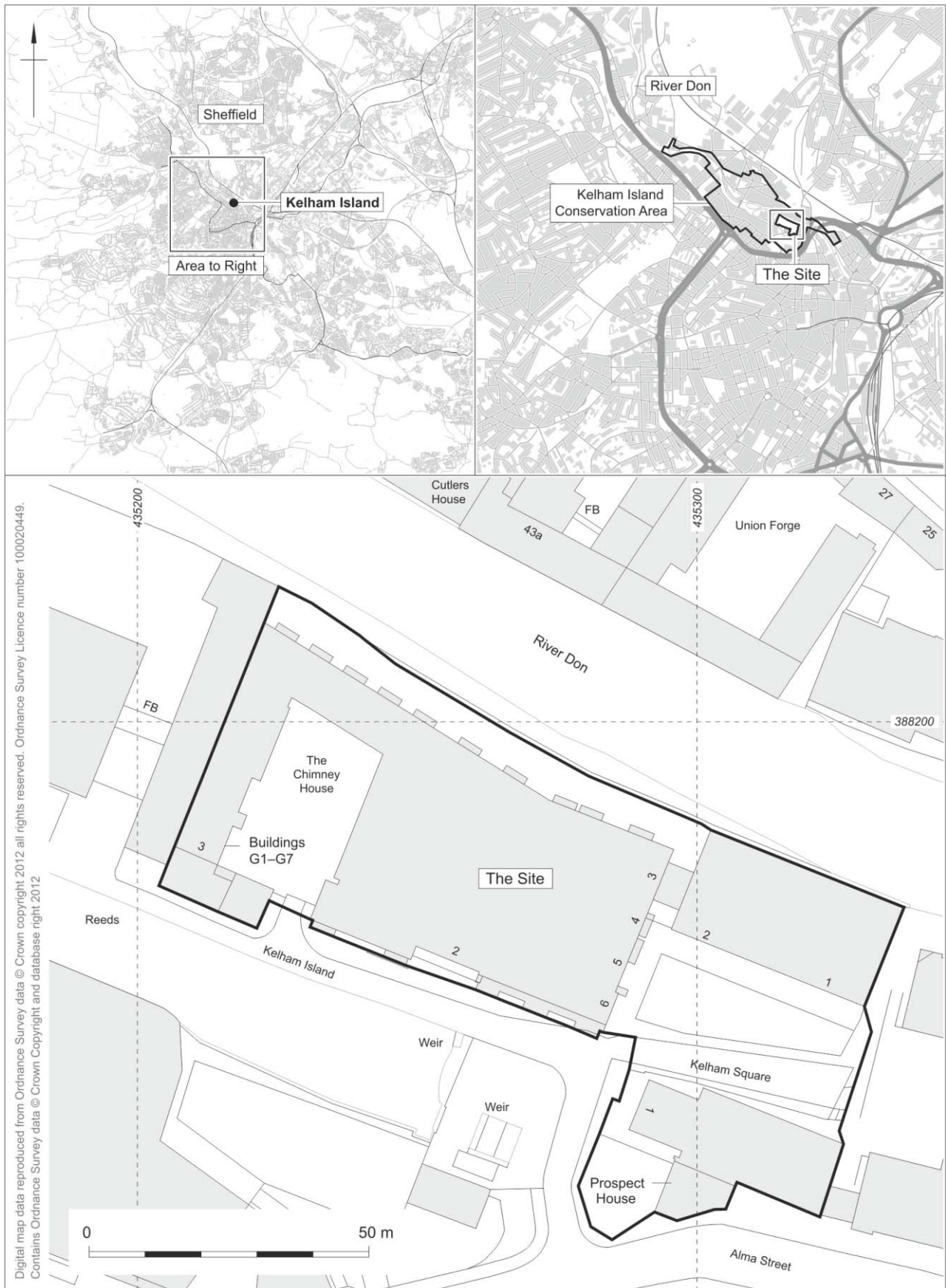


Figure 1: Site location plan

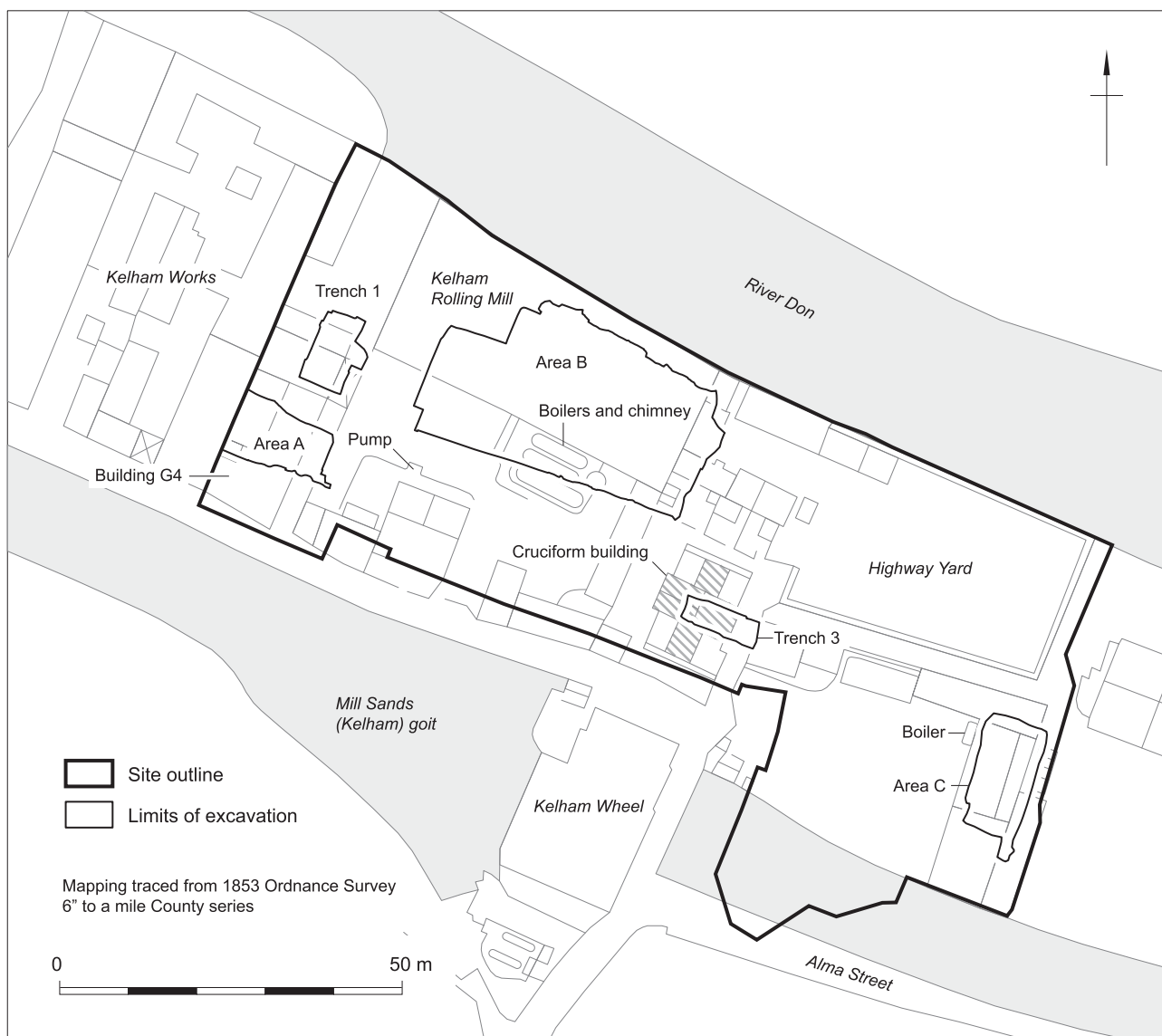


Figure 2: Trench and area excavation locations shown in relation to structures depicted on the 1853 Ordnance Survey map

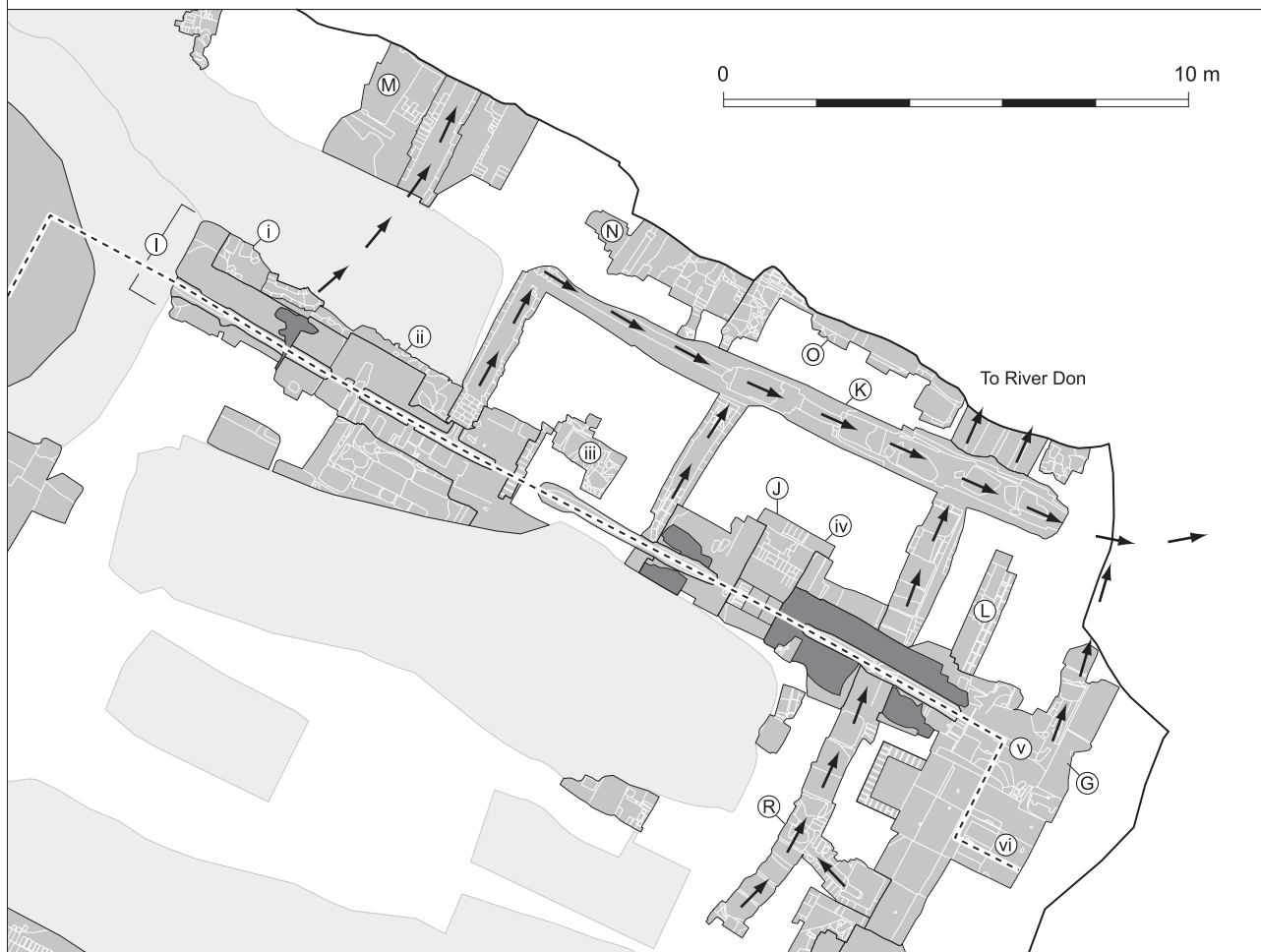
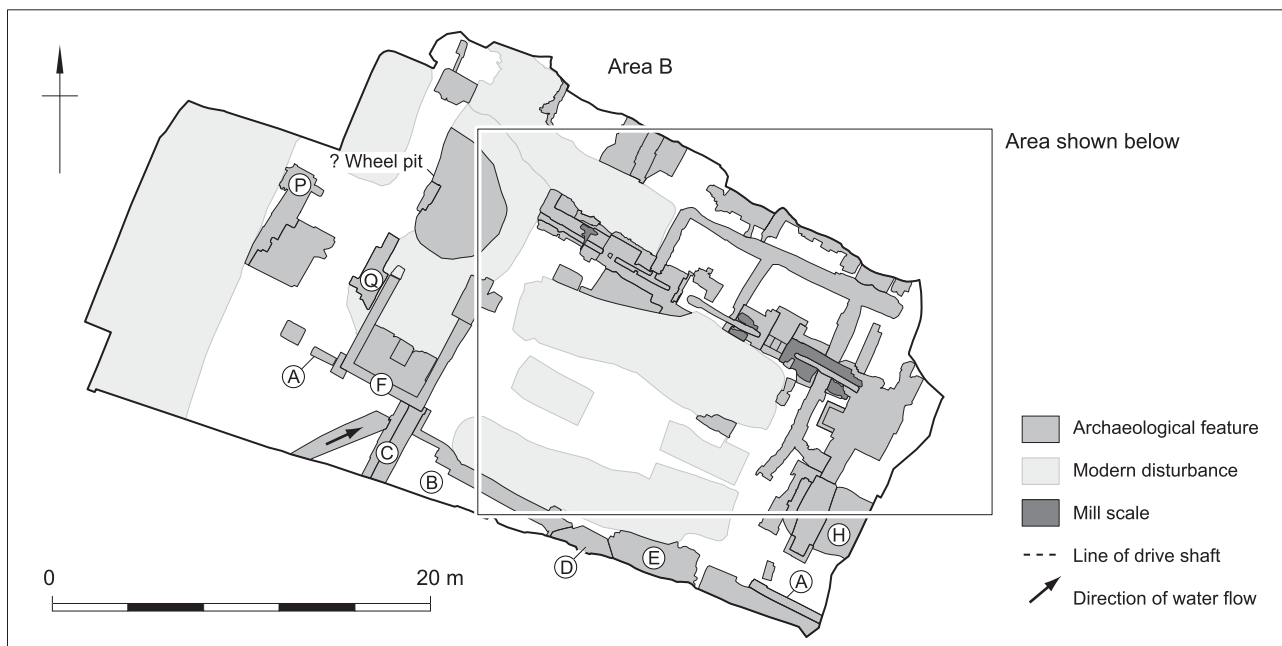


Figure 3: Area B plan, showing details of the rolling mill stands

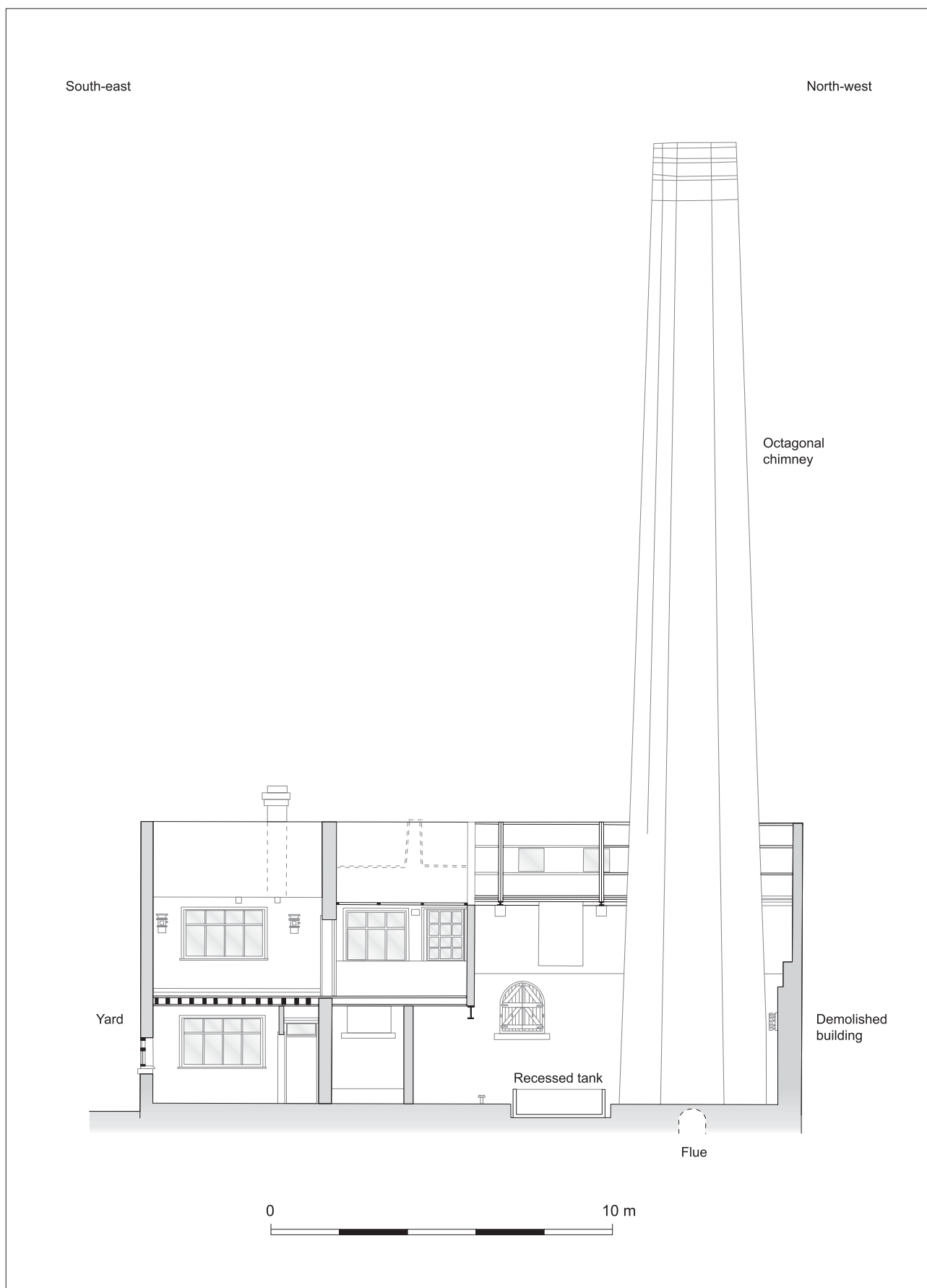


Figure 4: Section/elevation of Building G and octagonal chimney

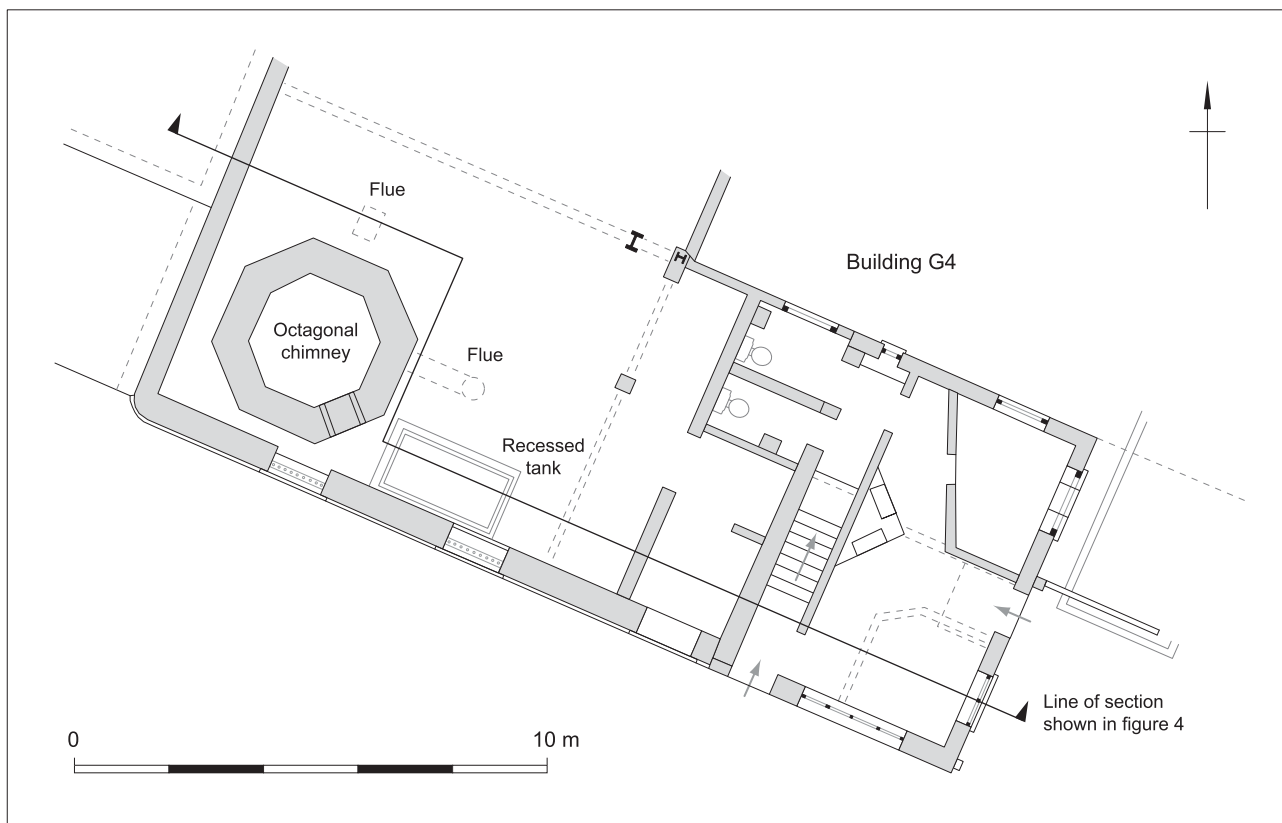


Figure 5: Floor plan of Building G

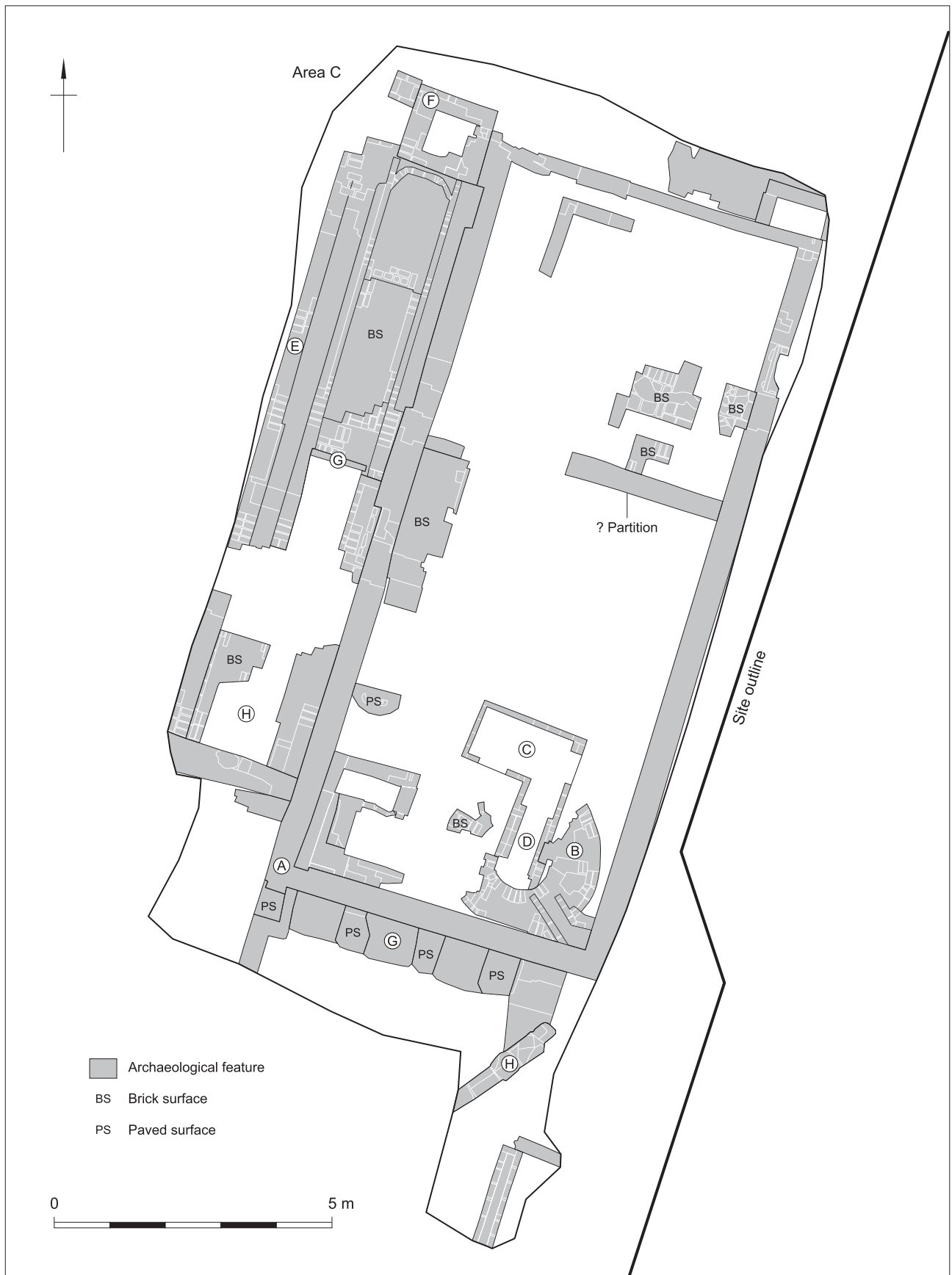


Figure 6: Area C plan

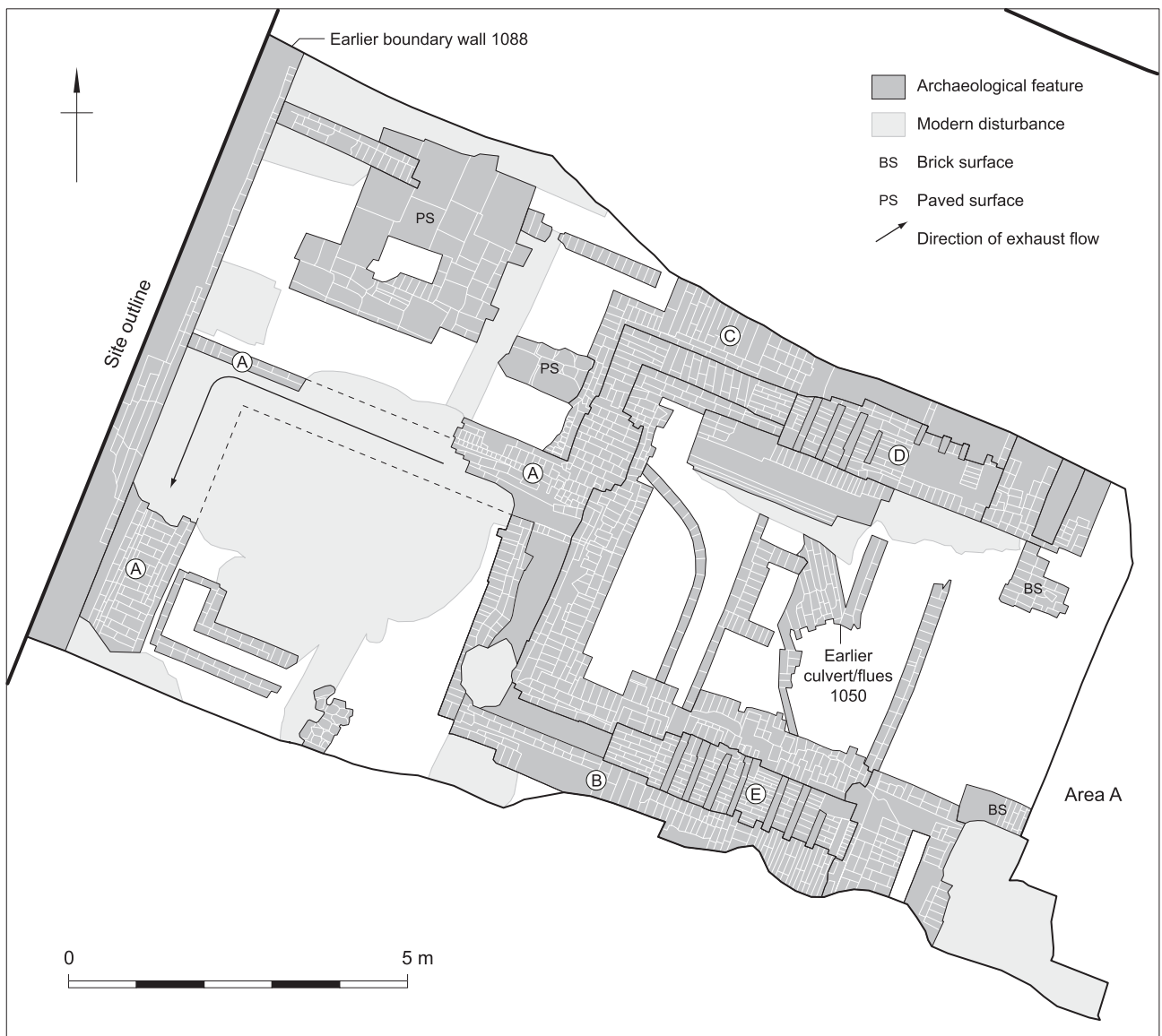


Figure 7: Area A plan



Figure 8: Pratt ware tobacco-pipe bowl, produced c. 1790–1830



Plate 1: Lancashire boiler base and part of interior of rolling mills, with modern concrete intrusions (area B). From south; scales = 1m and 2m (© University of Sheffield. Reproduced by permission)



Plate 2: Structure G – drive shaft housing and fly-wheel location (area B). From east; scales = 2m (© University of Sheffield. Reproduced by permission)



Plate 3: Rolling stands i – iv and associated drains (area B). From south; scales = 1m and 2m (© University of Sheffield. Reproduced by permission)



Plate 4: Building G4 – street frontage (© University of Sheffield. Reproduced by permission)

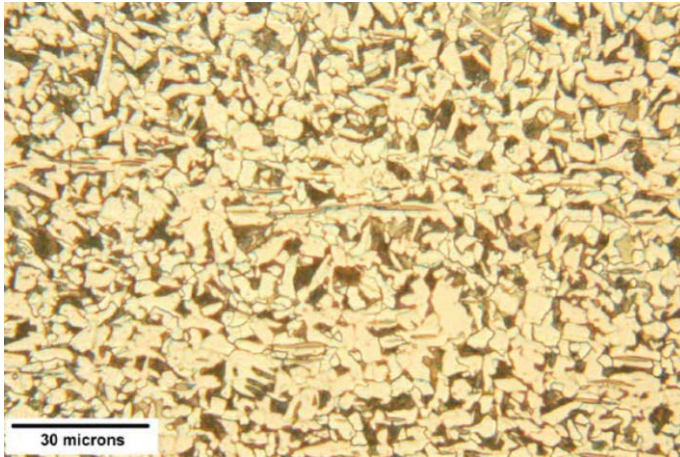


Plate 5: Metallographic section of rail showing generally uniform microstructure of pearlite and ferrite



Plate 6: Highway Yard eastern wall (© University of Sheffield. Reproduced by permission)



Plate 7: Building A with boiler 'annexe' on west side (area C). Scales = 1m and 2m (© University of Sheffield. Reproduced by permission)



Plate 8: Building A – structures B, C and D in south-west corner (area C). Scales = 1m and 2m (© University of Sheffield. Reproduced by permission)



Plate 9: Prospect House – east elevation over the goit (© University of Sheffield. Reproduced by permission)



Plate 10: Prospect House – south elevation; note first floor central window replacing earlier 'taking in door' (© University of Sheffield. Reproduced by permission)

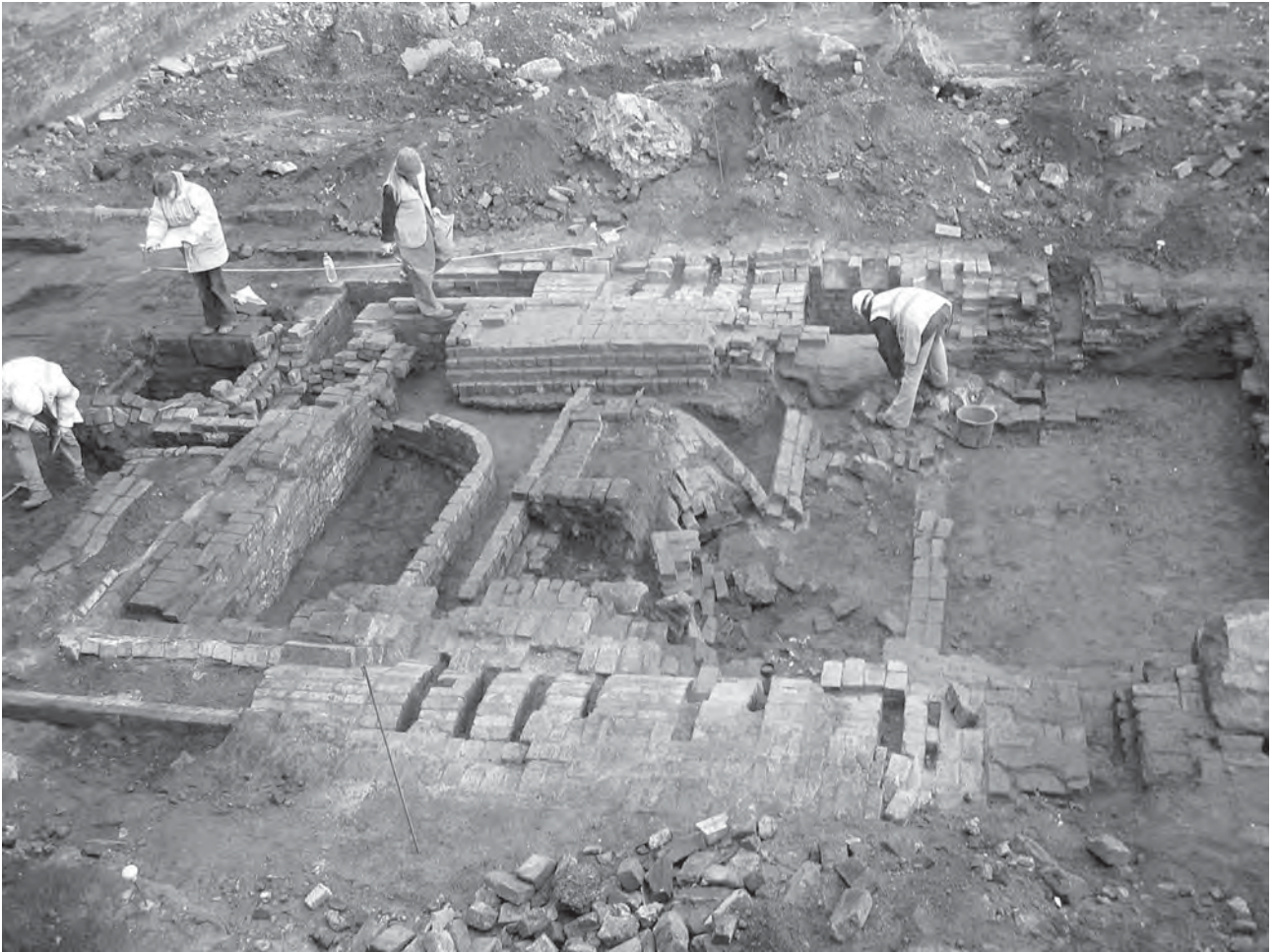


Plate 11: Brick kiln (and earlier) flues (area A). From south (© University of Sheffield. Reproduced by permission)



Plate 12: Brick kiln building, with octagonal chimney (building G4) to rear. From north-east (© University of Sheffield. Reproduced by permission)

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Plate 13: 'Lizzie Ward' working at the rolling mills on Kelham Island, apparently in 1914, with Kelham Island Firebrick Works in the background (Sheffield Archives and Local Studies Library ref. s00069. © Sheffield City Council)



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