Cyfarthfa Coke Works (The Old Thorn Lighting Works) Merthyr Tydfil

Excavation report and analysis

October 2017

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A report for Hammerson Plc
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Contents

Page

Figures

Plates

Tables

Summary

The Glamorgan-Gwent Archaeological Trust Ltd (GGAT Projects) were commissioned by Hammerson plc. to undertake an archaeological excavation and watching brief in advance of a development on the site of the former Thorn Lighting Works and Cyfarthfa Coke Works, Merthyr Tydfil, in order to fulfil the conditions of their planning permission to redevelop the site. The majority of the archaeological work was undertaken over the summer of 2013, with a watching brief continuing into late 2013.

Archaeological remains relating to the whole of the period of operation of the Cyfarthfa Ironworks were discovered, providing a fascinating insight into the history of the works.

The earliest, and most unexpected, recorded remains were a section of the canal built by Anthony Bacon for the works in the late 18th century, which included a lading ramp, and a passing place for tub boats. This canal was in existence from at least 1777 and was finally phased out of use by 1840. The canal was then re-used to contain a brick culvert supplying water to the coke yards, before being buried and lost by later development. This later development included ephemeral remains relating to the operation of the coke yard between the late 18th to mid-19th centuries. These features included stone tramway sleepers, culverts and other related structures. The remains of a set of Thomas coke ovens were also recorded, which date to between 1851 and 1856. Although damaged, these remains are some of the only archaeologically examined Thomas ovens of this period and have provided new information on the construction of this important transitional technology.

The most extensive remains uncovered were those of the Coppée coke ovens and associated coal washery. The layout of the Cyfarthfa Coppée ovens, which date to 1882, was unique, consisting of a double row of ovens separated by a central storage area. The Coppée ovens were part of an attempt to modernise the works by conversion to the production of steel and huge investment was made. The facility was provided with a Carr's disintegrator for reducing the washed coal to a size suitable for use in the Coppée ovens but the system was modified in 1894/5 by the addition of a Sheppard Feldspar Washer, and both phases the system were visible in the recorded remains. The remains of the Sheppard equipment are the only archaeologically examined remains of this type of plant.

The Coppée coke ovens themselves were heavily truncated, although the north battery and associated heat flues were comparatively intact, providing valuable information on the construction and operation of these features. It is evident that part of the ovens was subject to remodelling, either through repair of heat damage or modification of the design; the work carried out at Cyfarthfa is the first time the remains of a Coppée coke oven has been archaeologically recorded and is likely to become a site type reference for future work in industrial archaeology.

The Cyfarthfa Ironworks finally closed in 1919 and had been demolished by 1926. Minor features relating to the later use of the site by the Thorn Lighting works, built in 1947, were recorded; these included a number of manhole covers and service pipes.

A laser scanning survey was conducted to record all upstanding remains prior to construction of the development. The data obtained is of sufficient quality to allow the construction of a 3-D model should it be required and will be a highly valuable resource for future researchers.

Analysis of a wide range of artefacts recovered confirmed the broad date range for the operation of the Cyfarthfa site, spanning the 18th, 19th and 20th centuries, although material from the early 20th century predominated. This analysis of the material has yielded information ranging from the type of hand tools being used to the type of bricks and mortars being used at the site and is an invaluable addition to the general body of knowledge concerning the operation of the Cyfarthfa works.

The extent of survival of structural remains strongly suggests that archaeological features relating to the operation of the works will survive outside the development area. This should be borne in mind when considering any future potential development in these locations.

A highly successful open day, facilitated by Hammerson plc., was held for local residents, at which approximately 1500 people took the opportunity to view the remains. The large attendance clearly demonstrated the high level of interest in archaeological remains of the iron industry in Merthyr Tydfil.

All work was carried out to the standards set out by the Chartered Institute for Archaeologists.

Acknowledgements

This project was managed by Martin Tuck MCIfA (Head of Projects). The report was written and compiled by Johnny Crawford BSc MA ACIfA (Project Officer). Specialist assessments were provided by Dr Tim Young, Joyce Compton, Hannah Bowden, Charlie James-Martin and Johnny Crawford. Illustrations were prepared by Paul Jones (GGAT Senior Illustrator). The field team consisted of Martin Tuck (Excavation Director), Charlotte James-Martin, Johnny Crawford, Jon Burton, Sophie Lewis-Jones, Andy Shobrook, Simon Ratty, Charlotte Bellamy, Dafydd Davies, Cassandra Davis, Emma Kington, Ewan Kennaway, Gareth Rees, Kim Dowding, Marie Wall, Robert Barratt and Sarah Baker

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Copyright notice

Abbreviations

GGAT:	Glamorgan Gwent Archaeological Trust
LB:	Listed Buildings Grade I, II and II* (Cadw)
NGR:	National Grid Reference
NPRN:	National Primary Record Number (in NMR)
PRN:	Primary Record Number (in SMR)
RCAHMW:	Royal Commission on the Ancient and Historical Monuments of Wales
SAM:	Scheduled Ancient Monument (Cadw)
HER:	Historic Environment Record (curated by the Glamorgan-Gwent Archaeological Trust)

1 Introduction

Project background and commission

The Glamorgan-Gwent Archaeological Trust Ltd. (GGAT Projects Division) were commissioned by Hammerson plc., to undertake a scheme of archaeological excavation and monitoring (watching brief) prior to and during the redevelopment of land forming an extension to the Merthyr Retail park, Merthyr Tydfil on land centred on NGR SO 03708 06785 (Figure 1). This land was formerly occupied by the coking works for the Cyfarthfa ironworks and latterly by the Thorn Lighting Works and the archaeological work was undertaken in order to safeguard against the loss of the archaeological resource associated with these sites. The archaeological programme of works was a condition of planning permission (condition 13 of Planning Application No. P/12/0219) to mitigate the impact of the development on the archaeological resource, and was undertaken according to an archaeological Written Scheme of Investigation (Dunning 2013) as a result of evaluation work which confirmed the presence of several buried structures (Sherman 2012). The Written Scheme provided the framework for the archaeological programme and this specification was approved by Merthyr Tydfil Borough Council, on recommendation by their archaeological advisors, GGAT Curatorial.

Location, topography and geology

The development area was situated approximately 1.25km northwest of the centre of Merthyr Tydfil, and bordered to the south by Swansea Road and to the west by the A470 (Figure 1). To the east of the site are the extant remains of the Cyfarthfa Ironworks (SAM Gm425), approximately 22m below the excavated area.

The solid geology of the immediate area is formed by deposits of the South Wales Lower Coal Measures which are overlain by till of the Devensian period (British Geological Survey, 2017).

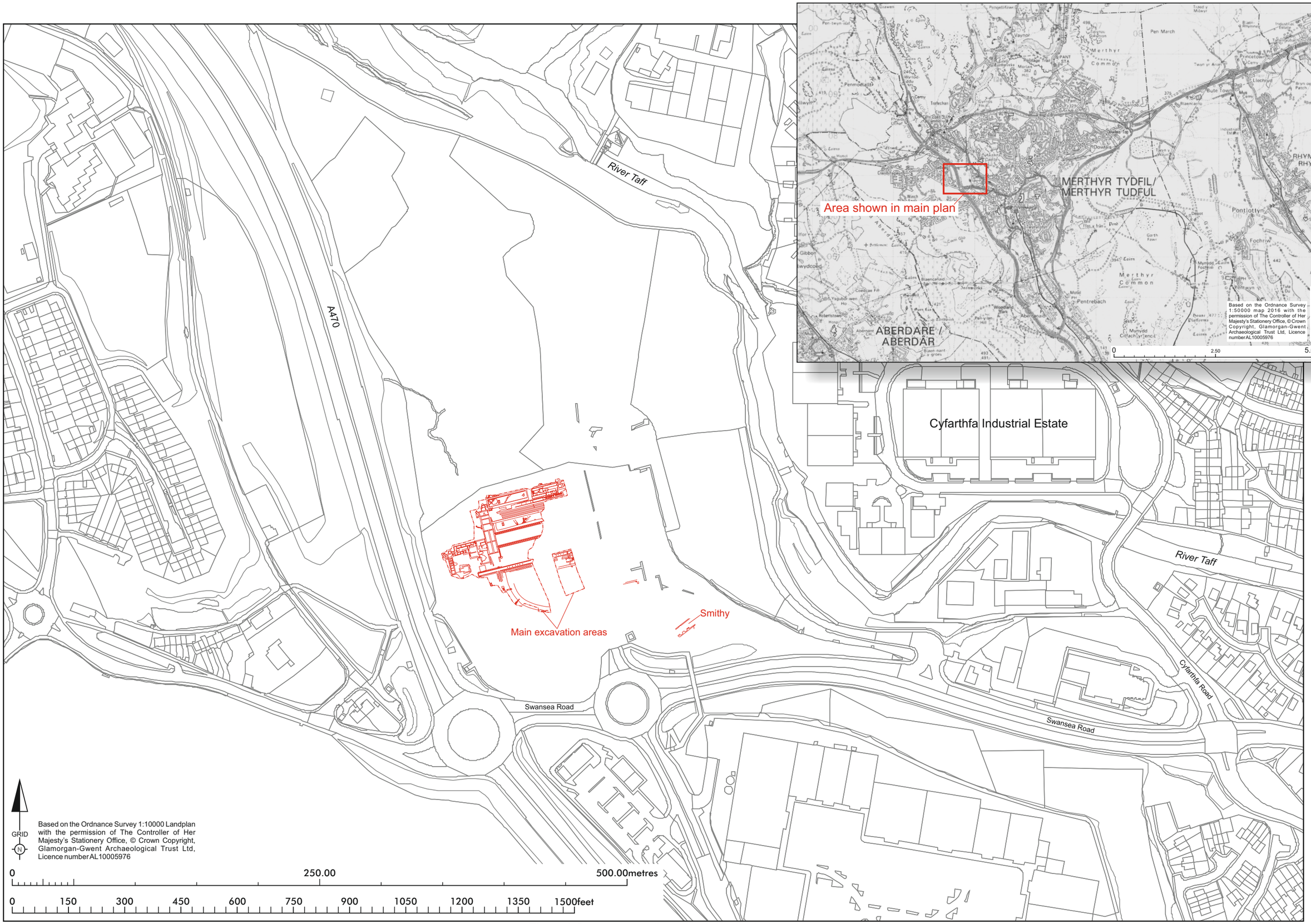


Figure 1. Location map of excavated remains (red).

2 Historical and archaeological background

The development area was situated in what was once the Coke Yard of the Cyfarthfa Ironworks and included multiphase forges, smithies, coke ovens, calcining kilns, coal stores, a marshalling yard and office buildings. Later, the site of the coke ovens was replaced by the Thorn Electrical Industries factory (variously known in available sources as the Thorn Lighting Works, and the Thorn Electrical Works), which overlooked the Hoover Transport factory on the main site of the Cyfarthfa Ironworks to the north. The name Thorn Lighting Works has been used throughought this report in connection with the former factory as this was the original name given to the factory in 1947.

The Cyfarthfa Ironworks (NPRNs: 34,078–34,080; PRN: 01169m) is a nationally and internationally important ironworks site, a large section of which is protected by legislation. These include the recently restored furnace bank, water management features and associated transport network. The main ironworks area, located east of the development, contains the remains of the furnace bank (PRN: 04960m; NPRN: 275,868), a run of six stone blast furnaces, first blown in 1765 and in use until 1872, notable for their size and extent, brick kilns (PRN: 02370m; NPRN: 34,081), and engine house (PRN: 02372m; NPRN: 34,082), together with the remains of the smelting house (PRN: 02373m; NPRN: 34,083) and boiler (all within SAM Gm425). Also included in the area is the Tai-mawr leat (SAM Gm479; PRN: 02435.0m; NPRN: 275,881) to the northwest of the furnaces and Pont-y-Cafnau Iron Bridge (SAM Gm424; PRN: 01090m; NPRN: 34,860; Grade II* Listed Building: Cadw ref: 11,408), a cast iron tramroad bridge, thought to be of *c.*1794, and possibly the world's first iron railway bridge.

Cyfarthfa, the fourth coke-fired ironworks to be founded in south Wales, is recognized as being nationally and internationally important for its historic associations and having played a key role in the development innovations in iron production technology, such as Cort's Puddling Process. The site is generally well presented and understood with good survival of both standing structures and buried remains, which may extend beyond the area currently protected through legislation (*i.e.* beyond the SAM area). This suspicion was, in fact confirmed by the work undertaken within the development area as presented in this current report.

Cyfarthfa Iron Works was founded on 29th August 1765, when Anthony Bacon and William Brownrigg leased 405 hectares of land, 13km long and 8km wide, for 99 years at a rent of £100 per year from William Talbot, 1st Earl Talbot and a Captain Michael Richards, two prominent local landowners. The extensive area leased enabled the works to be supplied with coal, iron ore, limestone, clay and water from the River Taff.

Bacon and Brownrigg engaged Charles Wood to build a leat, a forge and a 15m high blast furnace for smelting iron ore. Wood, who had pioneered the potting and stamping method of refining pig iron into wrought iron, and patented it in 1763, supervised the construction between April 1766 and May 1767, keeping a detailed diary of this work which has partially survived (Gross 2001). Initially, ore was smelted with charcoal but as supplies dwindled the works began to use coal instead, which necessitated an expansion of mining activity and the means to transport the resulting ore and coal.

The works initially operated a single furnace and concentrated on the production of pig iron. On 22nd July 1777, Bacon bought out Brownrigg and went into partnership with Richard Crawshay and they began to manufacture cannon for the Board of Ordnance, initially for use in the American War of Independence, and later for the long series of wars with Revolutionary and Napoleonic France. Following Bacon's retirement in 1783, Crawshay gained control of the Cyfarthfa Works, although he did not become the outright owner until 1794. Thereafter, the works remained in the Crawshay family, passing from Richard Crawshay, who died in 1810 to William Crawshay I, who directed operations from his London office, while the day to day management, including the great expansion of the works, fell to William Crawshay II, who was responsible for the building of the nearby Cyfarthfa Castle in 1824.

The works at Cyfarthfa was the first in the area to change to the production of bar iron, which ultimately lead to Cyfarthfa becoming the largest ironworks in the world by 1806. Instrumental in adopting Cort's Puddling Process soon after it was patented in 1784, were William Crawshay in partnership with Watkin George, Cyfarthfa's foundry manager, perhaps most notable for his involvement in the design of several of the area's early cast-iron bridges, including the surviving Pont-y-Cafnau and for the development of the Ynysfach ironworks as a sister site to Cyfarthfa. Even from its earliest days however, Cyfarthfa was forced to buy in supplies of pig iron from both the nearby Dowlais and Plymouth ironworks for refining to maintain its production of bar iron. Anthony Bacon had used Cyfarthfa for the manufacture of armaments in the 1770s and in 1782 granted permission to Samuel Homfray to construct a cannon boring mill within the works. Thereafter, manufacture of ordnance, particularly for the Royal Navy became a significant business for Cyfarthfa, so much so that a pile of cannon balls was included in the Crawshay family crest.

The layout of the works at the time is detailed in a view drawn around 1800 by William Pamplin, one of Richard Crawshay's employees; this shows four furnaces and associated charging houses and casting sheds used in the production of pig iron, as well as the 48ft (approximately 15m) diameter waterwheel which powered the bellows. Immediately to the north is a large building with numerous chimneys that housed the puddling furnaces and rolling mills. The early 19th century layout of the works and its associated features appears on Ordnance Survey maps and surveyors' drawings of the period. Also detailed are tramroads leading to the Glamorganshire Canal.

Research carried out for the current report has, however, revealed the presence of an earlier map of the Cyfarthfa works. The Glamorgan Archives contains a file relating to a legal dispute involving the Cyfarthfa Iron and Steel works (Glamorgan Archives DG/F/9/10). The file contains a copy of a sketch map of the Cyfarthfa ironworks, purported to date to January 1795, from estate maps belonging to the Dynevor (Lord Talbot) estate which would make it the earliest known representation of the layout of the Cyfarthfa works (Plate 1). The land formed part of the Llancaiach estate, jointly owned by Lord Talbot and Captain Richards. Despite being a sketch map, it contains a wealth of important detail, including the location of Homfray's previously lost cannon boring mill (annotated 'l' on the map), the coke yard ('c') and mine yard ('d'), a tramway connecting the Cyfarthfa mine yard to the Ynysfach site ('a') and the presence of five blast furnaces. These last two features present something of an enigma in the

conventionally understood history of the Cyfarthfa Ironworks; the Ynysfach Ironworks were not designed by Watkin George until 1801, with the tramroad being necessarily later or at least contemporary. By the same token, the Cyfarthfa works was believed to have had just four blast furnaces up to 1806. The conclusion must be that either the sketch map is incorrect, or that the conventional understanding of the development of the Cyfarthfa Ironworks is incomplete. It has not been possible to locate the original estate map in the Glamorgan Archives and at present, the discrepancy remains something of a mystery.

Plate 1. Possibly the earliest known plan of the layout of the Cyfarthfa Ironworks. Purporting to date to January 1795, the plan depicts several inconsistencies with the accepted development of the works. This includes the presence of a tramway from the Ynysfach site (annotated 'a', adjacent to the canal in the top left quarter) and an additional blast furnace. (Glamorgan Archives DG/F/9/10)

Whatever the sequence of development, the Cyfarthfa works benefited from the upsurge in railway construction during the 1830s and 1840s, and in 1833 a new mill was built as a result. However, shrinking export markets, among other difficulties, were to affect business in the second half of the 19th century. Robert Thompson Crawshay could see no future in the iron industry and under his reluctant leadership, Cyfarthfa failed to follow the lead of other local ironworks such as Dowlais, and invest in the new steelmaking process developed by Henry Bessemer in 1856 and by the 1860s, the Cyfarthfa works were effectively outdated. The 1870s were characterised by dwindling quantities of raw materials, high import costs, low prices for products and labour relations problems. A belated programme of modernisation was commenced in April 1874, coinciding with the commencement of a year-long strike over wage reductions, but the furnaces remained out of blast until 1879 and the death of Robert Thompson Crawshay.

The ironworks of this middle and later period was shown in detail on the Board of Health map of 1851 (Plate 141). The works were located either side of the River Taff and connected by two tramroad bridges, in addition to Pont-y-Cafnau. Notable features extant at the time, apart from the blast furnaces, were casting sheds, a smithy, and a coke yard (similar to that illustrated by Pamplin in 1800, Plate 140) with extensive coke ovens to the rear of the charging bank and the Tai-mawr leat to the northwest of the works.

Following the death of Robert Thompson Crawshay, his three sons, trading under the name of Crawshay Brothers (Cyfarthfa) Ltd. embarked on the change to the manufacture of steel using the Bessemer Process for blowing air through molten iron. Steel production commenced at Cyfarthfa in 1883-84, over 25 years later than the Dowlais works, using five new blast furnaces and four Bessemer converters. A new rolling mill was built in 1885 and, by 1887, the works employed 4,000 people and had an output of up to 76,200 tonnes a week. Of relevance to the current report, construction of the Coppée coke ovens was commenced in 1882 in order to coincide with the change in technology from iron to steel production.

These measures were insufficient, however, to prevent the business going into terminal decline and in 1902, the ailing Cyfarthfa works was acquired by GKN (Guest, Keen and Nettlefolds), successors of the rival Dowlais works. In spite of additional investment, the works proved unprofitable and production ceased in 1910, with a brief reprieve during the First World War (Roberts 2005) when it was used in connection with the production of steel for artillery shells. The Cyfarthfa works finally closed in 1919, never to re-open, ending 154 years of iron and steel production on the site, and providing a body blow to the local social and economic fabric of Merthyr.

On the 26th of January 1926 the Merthyr Express carried a short news article on the demolition of the Cyfarthfa works, in which the journalist states:

> The work of demolition, as carried out by the Provincial Coal and Shipping Company Ltd, proceeds apace …. The last stack fell just short of a month ago. About 100 men are engaged on the work of destruction, and it is computed that within a year the work will be completed. The material from the works is being used for a multiplicity of purposes. Millions of bricks have been taken away. A great deal of masonry has been acquired by the Cardiff Corporation for their new waterworks.

In the mid-20th century the development area was selected as the site for the Thorn Lighting Works, making incandescent lamps. The factory was constructed in 1947 and remained broadly successful until the early 1990s, when competition forced Thorn to decide between continuing operations in Merthyr or Eastern Europe, and the works closed. The factory was demolished in 1993, with the site remaining derelict until commencement of the redevelopment of the site by Hammerson plc. in 2012/2013.

The role of coke in iron and steel production

The production of coke was, and remains, a fundamental part of the process of iron and steel production. Without coke, a high quality product is simply not achievable and the development of technology for the more efficient production of coke was vital in the development of the iron industry as a whole.

In the earliest days of the industrial revolution, charcoal was the fuel of choice for iron production; charcoal had been used in this capacity since the Roman period as it burned at high temperatures and produced few impurities. However, by the 17th century, sources of timber in Britain were rapidly disappearing and experimentation with other fuel forms was undertaken. In 1710, Abraham Derby pioneered the use of coke in a blast furnace for the production of pig iron. By the mid-18th century, the use of coke in blast furnaces was routine although not yet on the huge scales characteristic of the Industrial Revolution.

Coke is essentially coal which had been heated in the absence of oxygen to drive off impurities, particularly sulphur, which would make the resulting iron brittle. Coking was initially undertaken by applying the same techniques as those employed in the production of charcoal; coal would be heaped up and set alight before being covered in a layer of earth to exclude the oxygen. Any gaps in the covering would admit air and result in full combustion occurring, and yield rates of only 30% coke from a firing were common. In 1768, John Wilkinson refined the process of coking in heaps by building each pile around a central brick chimney, which by the mid-19th century had boosted the efficiency of coking in heaps to the extent that yield had increased to approximately 65%. Beehive ovens were a further refinement, and were the first dedicated structural features for the mass production of coke. Their use was pioneered in Sheffield in 1802 and by the mid-19th century, tens of thousands were in operation nationally. There is no physical evidence for the presence of beehive ovens at Cyfarthfa, with their characteristic form, although it is possible they may have been used.

Different varieties of coke oven were developed and utilised from the mid-19th century onward but the most common in use within South Wales was the Thomas oven, also known as the Welsh oven due to its ubiquity in that region. This is the type discovered at Cyfarthfa, beneath the remains of the later Coppée ovens and is discussed in more detail below. The Coppée oven design itself was simply a much more massive and efficient refinement of earlier designs used on the European continent. Its structure and impact are also discussed below but it is important to stress that all of the above methods of coking were developed in tandem with improvements in general iron and steel production technology and are just as reflective of the development of the Industrial Revolution as blast furnaces or other facilities that are often perceived to be more ‘glamourous’.

Thus, the story of the Cyfarthfa coke works and its surrounding area is an integral part of the story of the Cyfarthfa Ironworks as a whole and the archaeological remains examined and recorded in this report should be contextualised as part of that national and internationally significant site.

3 Methodology

On-site methodology

The archaeological programme of works was carried out in accordance with the methodology detailed in *Old Thorn Site, Merthyr Tydfil, archaeological written scheme of investigation*, (Dunning 2013), the main points of which are summarised below.

Modern overburden was excavated by a mechanical excavator with both toothed and toothless grading buckets, under archaeological supervision, to the top of the first archaeological horizon and also to assist revealing significant archaeological structures buried beneath mining waste.

Following removal of any overburden, sufficient cleaning and excavation of features and deposits was undertaken by a combination of mechanical and hand means to establish the extent, character, function, and date of any archaeological remains. No excavation of the area beyond that required for the development's formation level was undertaken, resulting in the survival *in situ* of significant archaeological remains.

A written record was made of all archaeological contexts using pro-forma context sheets, in accordance with the GGAT *Manual of Excavation Recording Techniques.* Digitised versions of these records (contexts 2000 to 2572) are contained at Appendix I to this report. The excavation was carried out to the *Standards and Guidance for archaeological excavation* (revised 2014) issued by the Chartered Institute for Archaeologists.

The excavated areas were surveyed using Leica GS08 GPS related to the OS National Grid. This data was used to produce a detailed plan of the features to aid in interpretation and presentation (Figures 2 and 19). All levels were related to Ordnance Survey datum. Levels for the majority of features are contained in the digital copy of the laser scan survey appended to this report.

A drawn record of archaeological contexts was made comprising scale plans and sections (usually 1:20 scale for plans and 1:10 scale for sections), and a standard set of conventions were used to depict various materials and features (Figure 3).

A full photographic record was made using 12 megapixel (minimum) digital cameras. All scale divisions shown within photographs are 0.5m divisions.

Due to the length of time required to draw conventional elevation drawings, and to make best use of an available technology, a laser scanning system was used to record all upstanding features. The laser survey was carried out using a Leica P16 capable of a resolution of 1.6mm to 50mm at 10m. The resolutions achieved during the survey were variable, based on the distance of the station from the features.

Whilst the nature and extent of the archaeology was indeed recorded exceptionally accurately, the results have proved difficult to translate into a format that can be readily accommodated within the current report. It was therefore decided to include the results of the laser scan as a digital appendix to the report, to be used as reference material for future research.

In terms of preservation by record, the laser scan represents the most complete and accurate record of the remains encountered at Cyfarthfa. The data gathered is tied into the National Grid system and the nature of the data is such that it would be suitable for the construction of a 3D model of the recorded remains should that be desired at a future point in time.

All classes of finds were retained, cleaned, processed and catalogued in accordance with the requirements of the Chartered Institute of Archaeologists' *Standard and Guidance for the collection, documentation, conservation and research of archaeological materials* (2001 revised 2014).

Provision was made for site visits to be made by relevant specialists when necessary and for monitoring visits made by the archaeological advisor to the Local Planning Authority (Mr Neil Maylan).

Post-excavation methodology

Recovered artefacts were processed, catalogued and sent for specialist analysis with synthesis of the resulting reports into this assessment stage report (Section 9). The individual specialist reports included an assessment of the artefactual assemblages and their potential for further study. Samples were also sent for specialist analysis and the assessment results form part of this report. All primary site records were digitised and collated to form a comprehensive digital archive.

An initial structural report was written which divided the site into four phases. Fundamental area plans have been produced to show only the most significant features of that area and are included as Figures 1-17. In some instances, it has been determined unnecessary to show context numbers for features that are made up of numerous numbers and group numbers have been allocated. Significant context numbers can be found within the Site Summary below (Section 4).

An archive of archaeological records relating to the fieldwork (including artefacts and ecofacts subject to the agreement of the site owners; excepting those that may be subject to the *Treasure Act* (1996) and/or *Treasure Order* (2002)) and an archive of records relating to the preparation of the reports has been prepared to the specifications in ICON's guidelines and *The National Standard and Guidance to Best Practice for Collecting and Depositing Archaeological Archives in Wales* (National Panel for Archaeological Archives in Wales 2017).

After an appropriate period has elapsed a digital copy of the report and full archive will be deposited with the *National Monuments Record*, RCAHMW, Aberystwyth, and a digital copy of the report and archive index will be deposited with the *Regional Historic Environment Record*, curated by the Glamorgan-Gwent Archaeological Trust, Swansea

4 Site Summary

The archaeological excavation and monitoring works took place across the extent of development site, which consisted of an area of approximately 2.3 hectares. The site had been left vacant since the demolition of the former Thorn Lighting Works in 1993 and had been covered by low scrub and undergrowth, with a large mound of material left in the centre. This material was removed by topsoil stripping, the majority of which had been undertaken by the time of commencement of the excavation work in July 2013. The archaeological work continued until November 2013, changing from an excavation to a watching brief as the groundworks phase drew to a close and actual construction began.

The uppermost deposit across the site (2000) consisted of black/grey loamy material containing isolated industrial deposits, clays and demolition material including brick, stone, metal and occasional modern pottery pieces. The depth of this overburden was highly variable, ranging from being at the surface, to a depth in excess of 2m below the ground surface. This built up deposit was almost certainly present as a result of the demolition of the Thorn Lighting works and probably represents an attempt to level the ground following that event. It is known however, that the contract for the demolition of the Cyfarthfa works, drawn up in 1924, specified that demolition material was to be used to backfill and level any uneven ground, so some of this material may have dated to that period (see below).

This deposit overlay a general deposit (2306) of coal, shale and coal dust that is likely to have been the predominant surface during the operation of the coking plant and probably during the life of the earlier coke yard. Different phases of coal deposit were believed to be present but differentiation between them was virtually impossible. The natural ground appeared to consist of yellow/grey coloured clay containing shale stone and decayed sandstone. It must be noted however that Charles Wood in his diary relating to the preparation of the site for construction of the works in the 1760s, noted that the undulating ground had to be extensively levelled and it is possible that some of the ground believed to be natural may in fact, have been imported material; levelling of the site appears to have been a recurring requirement at Cyfarthfa.

Four major phases of activity were noted within the remains recorded on the site. These ranged in date from the late 18th century to the mid-20th century. Individual summaries of the results from each of these phases are given below.

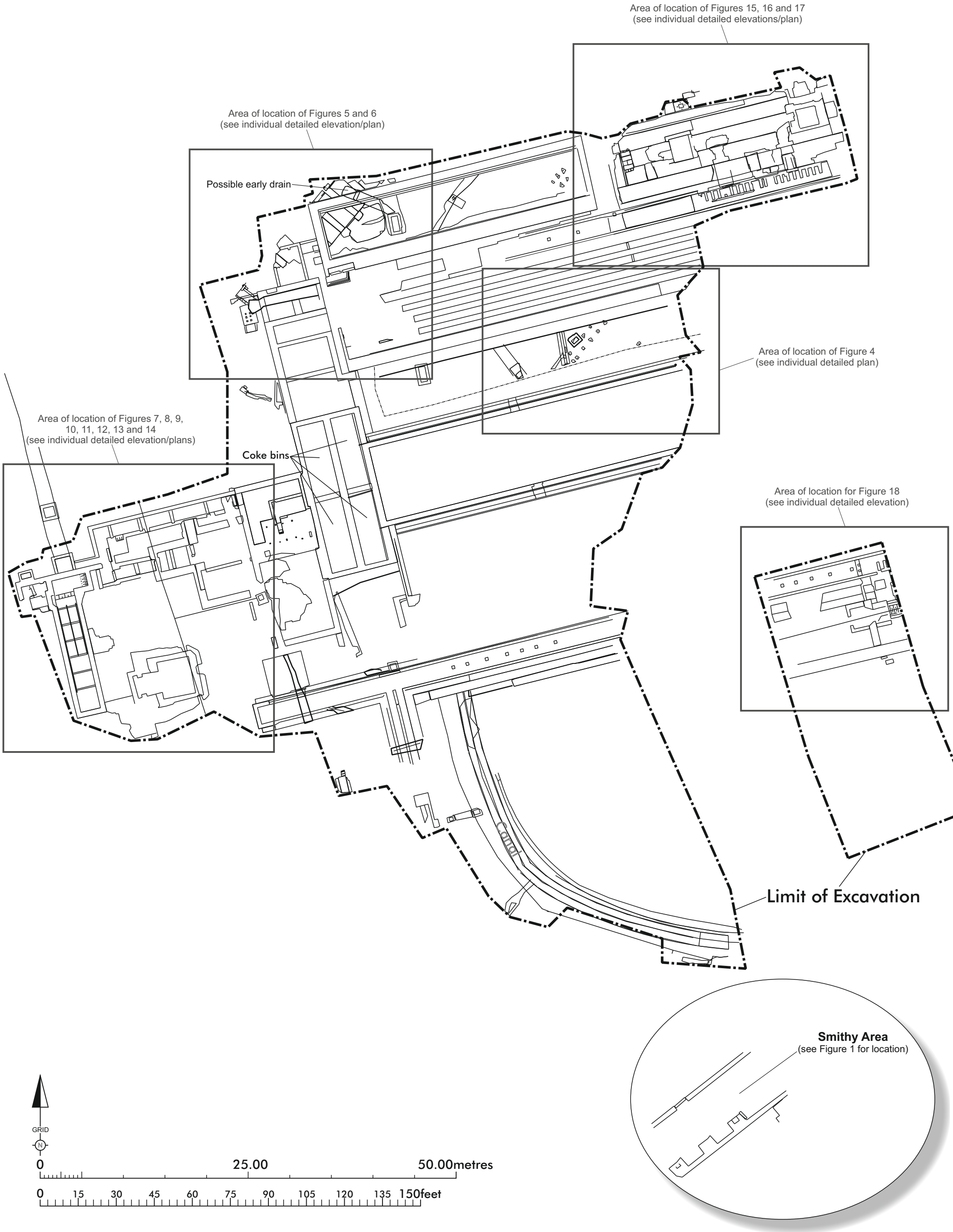


Figure 2. Extent of surveyed remains of the Cyfarthfa Coke works and location of detailed figures.

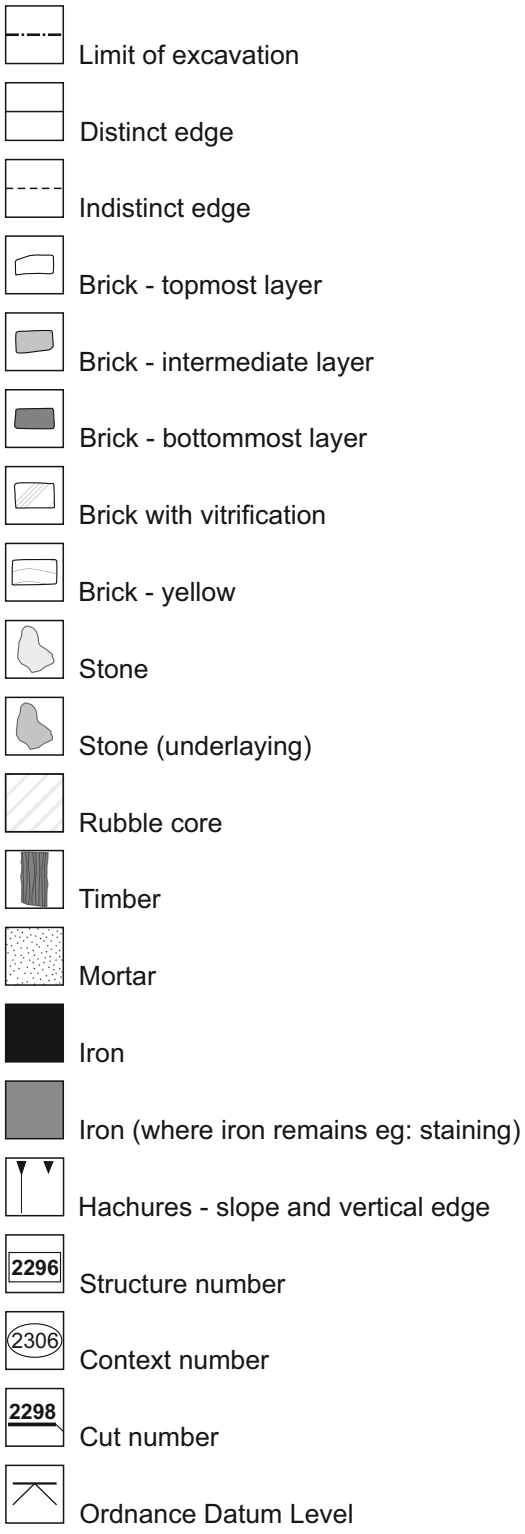


Figure 3. List of conventions used in the detailed plans and elevations/sections.

5 Phase 1. 1766 to circa 1840

The earliest archaeological activity noted on site was associated with the operation of the Cyfarthfa Ironworks by Anthony Bacon in the latter part of the 18th century. The evidence consisted of a curving section of canal exposed in the south of the site. Despite a lack of artefactual evidence, phasing was established through its relationship with later features, supported by very limited documentary evidence.

Prior to the construction of the canal, ironstone and coal was brought to the site by road, carried in panniers on the backs of donkeys and ponies (Pedler 1930 p.26). The pack horse method was replaced rapidly by the construction of a canal, and given that canals were already in use in Anthony Bacon's home region of Salop, it was probably always the intention to construct one for Cyfarthfa. The canal provided the main means of transporting raw materials for the ironworks, remaining in use apparently until the 1830s (Hadfield quoted in Gross 2001, p.xxii) although see Pedler, below. The canal seems to have been constructed after the time of Charles Wood, the diary keeping engineer who supervised the initial construction of the works, as no mention is made in the diary, the surviving portions of which date from 1766 to 1767, of a canal. This dates the canal construction to after 1767 and before 1795, when it is shown on the estate map of Lord Dynevor (Plate 2). However, it is likely that the canal in fact belongs to the period before Anthony Bacon's death in 1786, when the works passed to the control of the Crawshays. Pedler believed the date of construction to be between 1780 and 1790, when mining operations in the Canaid Valley, located south of the development area, began in earnest. However, a brief legal reference, concerning a lease of land by Anthony Bacon from one Ann Richard dated 14th October 1777 mentions "a Piece of Land used as a Coaking [sic] Bank, with a Piece of Wood Gro'd [sic] adjoining, at Cyfarthfa Furnace, also the Land under the Canal, and the Land taken for a road on the Lower side therof…" (Lloyd 1906 p.49). From this reference it seems that the canal supplying coal and other raw materials to the area used for coking was certainly in existence in or before 1777.

Plate 2. Extract from the map of the Cyfarthfa Iron works taken from a Dynevor Estate map of January 1785. The uppermost curving section of canal adjacent to the buildings labelled 'b' is the section exposed during the archaeological work in 2013. Area 'd' is the mine yard and 'c' is the coal yard (Glamorgan Archives *DG/F/9/10).*

According to Pedler (1930 p. 27) the canal was in use up to the period 1835-40, and he claimed to have known someone who in her youth, had helped her father haul the boats along the canal. There is a suggestion that the canal is present on the 1832 OS map of Merthyr Tydfil although the detail is relatively poor. No canal is illustrated within the excavated area on the Tithe map of 1850 and it must be assumed that the main part of it had been filled in prior to that date.

Anthony Bacon's canal

(Contexts 2002, 2003, 2005, 2005, 2006, 2007 and 2008). The uppermost surviving element of the canal wall was located at an elevation of 202.2m OD and was almost 2m below the general ground level for this area of the site. The exposed length ran for approximately 50m in a gentle curve from almost due east to due north. This alignment makes little sense in relation to the later coke yard depicted on the 1850 Board of Health Map and demonstrates that not only is it an early feature, but the layout of the mid-19th century coke yard appears to be a complete re-ordering of the operation and not merely a refinement of what already existed. The alignment is a match for part of the canal traversing the coal yard [sic] depicted on the copy of the 1785 Dynevor estate map which would place it close to two saw pits also shown on the map (labelled 'b'). No trace of these saw pits was noted during the excavation but it is highly likely, given the depth of the buried remains of the canal, that elements of the saw pits survive within the development area. The arrangement of the canal as depicted on the map is unusual, featuring as it does a cross-junction and no obvious turning circle for boats. A bridge over the canal appears to be depicted at the northern end but no similar feature is shown close to the excavated areas.

The construction cut for the canal was visible in the upper surface of a compressed coal deposit (2344) and in which it was noted that it was engineered to leave little in the way of backfilling space after insertion of the side walls. This suggests that the area was already in use for coal processing and coking at the time of the canal's construction, which supports the limited documentary account to the effect that previously, raw materials had been brought to the site by pack animal.

On initial excavation, the canal held little water, although it began filling in the 48 hours after being exposed; there was no obvious flow in any direction and the water made measurement of the base depth of the canal difficult. Both the side walls were built with squared off sandstone blocks (the local Pennant sandstone) bonded with hard textured, light grey lime mortar. The outer face of the walls presented a neat vertical face in contrast to the irregular rubble fill behind. It is tempting to suppose that the very neat face presented by the sides of the canal was done by the same masons about whom Charles Wood complained in May 1766 when he stated that they were so fond of elaborately dressing stone that the work was taking longer and proving more expensive than anticipated (Gross p.2-3). At its eastern exposed end, the canal had a width of 2.9m but very soon the wall widened, through the introduction of a curved section to the south wall, to 3.3m. Curiously, after the widening, the south wall followed a straight line for at least 4.6m; although the south wall of the canal certainly curved towards the north, the point at which it made the turn was noted as it remained buried. This widening and straightening of the canal was almost certainly to facilitate the passage of the tub boats during lading and unlading (see Plate 3). The designed original depth of the canal was difficult to ascertain due to the presence of water at the time of recording. The canal however, had a natural clay base (2008) at approximately 1.6m below the top of the east canal wall, although it was impossible to confirm whether this was the original base or a sedimentary base built up over time. This brown clay had a slightly greenish tinge to its colour but initially was not believed to have been puddled clay. It is almost certain however that the canal would have been lined with clay on initial construction to aid waterproofing.

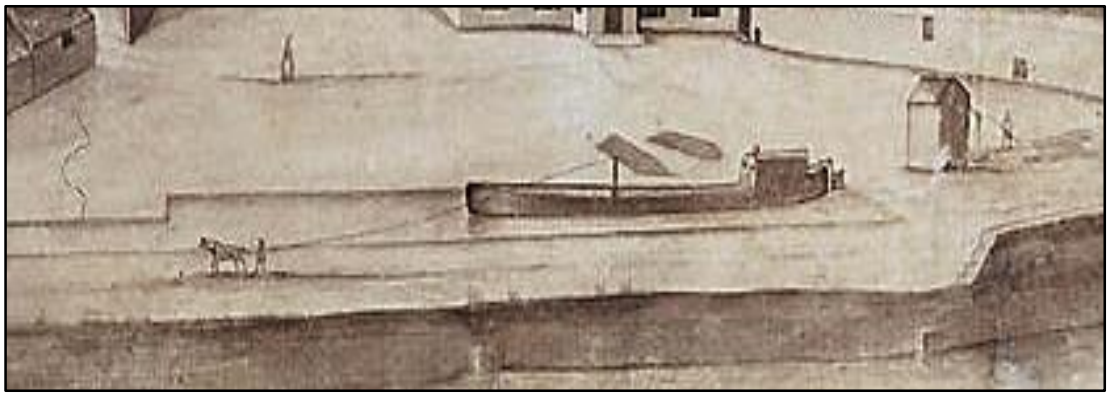


Plate 3. Extract of a drawing by Pamplin of the Cyfarthfa Ironworks dated between 1791 and 1800. Although this image depicts the Glamorganshire canal near the lower works, note the widening of the canal wall. A very similar feature was noted during excavation of Anthony Bacon's canal (Cyfarthfa Castle Museum)

As an indicator of the potential build-up of sediment within the canal, it was estimated that the fine dark brown sediment (deposit 2007) within the brick culvert constructed within the canal, had reached a thickness of 1m.

In his historical account of the local area, Pedler states that the boats used on the canal were "Small, iron flat-bottomed boats, or barges…drawn by one or more persons according to the number of boats joined together." (Pedler 1930 p.27). Whilst no evidence of the boats themselves was noted, it is possible that the buried remains of one or more tub boats lies in the course of the canal, and it is almost certain that they were of a type very similar to a surviving example kept on the Shropshire Canal. The recorded length of tub boats on the broadly cotemporary Shropshire Canal was 19 Feet 9 inches (6m) with a width of 6 Feet 2 inches (1.87m) (Shropshire Tub Boats 2017). The canal dimensions noted at Cyfarthfa were similar, suggesting that the tub boats employed were slightly narrower and probably slightly shorter. The south canal bank at the straight length of the south wall consisted of an angled deposit of compressed coal dust and fused iron slag forming a distinctive ramp. This ramp appeared to have formed or been engineered to facilitate the easy sliding or more likely shovelling of cargo in and out of the boats. This may have been assisted by the fact that the south canal wall was approximately 0.5m lower than that on the opposite side (Plate 4). There was no similar ramp on the opposite side of the canal and it may be no coincidence that the estate map of 1785 shows buildings on the south bank close to this location; although described as a saw pit, they may also have had a storage or other function.

Plate 4. Anthony Bacon's canal. The orange/brown ramp on the right of the photo is believed to be a lading and unlading ramp, to aid transfer of materials to and from the tub boats. Note also the curved walling to allow the widening of the canal for the passage of boats. Note the later brick culvert built into the canal. View to east.

The canal had been rendered un-usable as such through the construction of an arched brick culvert (2005) along much of its course (Plates 5 to 6). The culvert roof had been destroyed at the eastern end at an unknown date, which allowed greater visualisation of the canal itself. The culvert spanned the interior of the channel for an internal width of 1.17m and had been built of a double row of un-frogged yellow refractory brick, laid on edge and bonded with soft white grey mortar containing coal flecks and shale-stone flecks. The external height from the arch to the base of the culvert was estimated to be 1.2m to 1.3m although the presence of water in the channel made assessment difficult. The roof of the arch contained occasional engineered breaks, possibly to allow visual inspection of the water level within, although it is difficult to see how this would have worked once the arch had been capped (see below). The interstices between the canal wall and the brick culvert had been filled with irregular blocks of sandstone, shale and coal dust (2006). Greater care had been taken to pack the areas closest to the culvert wall but otherwise, the packing appeared to be somewhat random, probably having been tipped in. As it progressed north, the culvert hugged the east wall of the canal, resulting in a wider gap which had been filled with packing 2006. At its greatest extent, this gap was 1.25m in width.

Plate 5. One of the few photographs to show the canal and culvert prior to filling with water. The construction of the culvert can clearly be seen, as can the stone packing (2006) around it. The light brown deposit towards the base may be the natural clay or a build up of silt in the channel prior to construction of the culvert.

Plate 6. The same features within the canal presenting their more usual view. The planning frame width is 0.6m.

There is little doubt that the canal was re-used as a water source in Phase 2 as the construction of the Coppée oven truncated the canal and the culvert at its north end. The brick culvert had been covered over for most of its length by a combination of randomly deposited Pennant sandstones and silty clay (2002) in order to both level the ground and protect the culvert beneath (Plates 7 and 8).

Plate 7. Stone capping 2002 which had been laid over the culvert contained by the canal. It is likely this had been placed both to level the area and protect the underlying culvert, the arch of which is just visible in the bottom right quadrant of the photograph.

Plate 8. Culvert 2003 on removal of the capping. Note its position within the channel of the canal. View to south.

The stones had been horizontally laid, with a depth over the centre of the culvert arch of 40mm-60mm and being correspondingly deeper as the arch curved away either side. A rough bridge or crossing point had been constructed over part of the northern stretch of canal and culvert (group 2021). This consisted of two linear stone spreads, oriented east to west at 90 degrees across the canal and placed 1.1m apart (Plate 9). Two pins, originally used for holding tramway rails were found, one *in situ* and it is believed that the group represents reinforcing for a tramway crossing. No similar crossing points were noted at other parts of the canal. Only 1.7m of the crossing had survived, spanning the canal/culvert; the remaining sections had been truncated either side.

Plate 9. Crossing point 2021 sited over culvert 2003. View to north east.

Several stone capped channels or drains, the most intact of which was drain 2203, were recorded on the uphill, south west curve of the canal, possibly to drain into that feature. Drain 2203 (Plate 10) was oriented south west to north east and had a surviving length of 5.4m. There was a suggestion that the drain branched into a second channel, also emptying into the canal but the whole feature was so damaged, the exact relationship was unclear. These features may have been adapted later to take account of the insertion of the culvert.

The construction and position of these features suggest that they were part of either the canal's original construction or were added in the early period of its operation. In addition to the sawpits depicted on the 1795 map, a number of buildings are illustrated on various maps of the development area from the mid-19th century onward and the drain possibly relates to a function of one of these but the truncation evident prevents any further assessment of function. The drains may, however, have been nothing more than an attempt to divert surface water into the canal which may have aided in keeping the water levels topped off. It is possible that there were numerous such features which acted in concert with an overflow to preserve water balance; there is the suggestion of an overflow for the canal to the north as depicted on the 1795 map but this was not noted during the excavation.

Plate 10. Stone drain 2203. The function and date of this drain remains unknown although its form suggests that it may relate to either Phase 1 or 2.

Coke and mine yards

The estate map of 1795 illustrates that the first phase marshalling yard (although the term would not then have been in use) was divided into two parts, one referred to as the 'coal yard' and the other as the 'mine yard'. These two areas appear to have been bisected by the canal and, as the names imply, it is reasonable to speculate that different activities were carried out in each area. In terms of quantity of evidence, very little dating from this period was encountered during the archaeological work. However, those features that were recorded allow us a glimpse of the activity being undertaken in the area during the first phase, and each is discussed separately below. A range of six "mine kilns", probably for roasting the iron ore prior to smelting, are depicted at the north east edge of the area, straddling both the mine and coal yards. This positioning would have allowed convenient loading of the kilns from both sides but unfortunately no trace of these kilns was noted during the archaeological work and it is believed they were destroyed by later developments at Cyfarthfa.

Coke yard – The vast majority of remains associated with Phase 1 and Phase 2 of the coke yard appear to have been destroyed by later activity. However, a group of features relating to the operation of the Cyfarthfa coke yard prior to the construction of the Coppée ovens was found preserved beneath the footprint of the northern coke bench. These remains consisted of a number of stone channels, stone sleepers for a tramway and a brick built chamber (Plate 11 and Figure 4). A tramway depicted in the "coal yard" on the 1785 Dynevor estate map would appear to share the alignment with the excavated stone sleepers but the evidence is simply too slight and the map too inaccurate to be certain about the dating of the excavated tramway sleepers. That being said, the earliest feature in this grouping is the stone tramway, the route of which has been cut by both a stone built drain and the brick chamber. These other features clearly pre-date the coke ovens, and there is a good chance that the brick chamber is one of the

rectangular features depicted within the coke yard on an annotated map of the Cyfarthfa Works dating to 1856 and are likely to be earlier in origin. As a result, although these features have been assigned as having a Phase 1, in all likelihood, these features may straddle the two phases, being equally plausible in the period before and after 1840.

Plate 11. Probable Phase 1 and 2 features located beneath the footprint of the 1882 north Coppée oven coke bench. The earliest feature is the set of tramway sleepers (2296) which has been cut by the later insertion of a stone drain (2301) and brick built chamber 2297). The construction cut (2300) for the Coppée ovens is clearly visible in the upper left quadrant. View to north.

Small sections of the original coke yard survived in a truncated form beneath elements of the Coppée coking plant. These remains consisted of a compressed coal surface into which had been set some stone sleepers, together with stone built drains and at least one rectangular brick chamber. The drain and chamber system may well have helped supply water for quenching the hot coke produced in the coke heaps that were probably located here.

The earliest feature within the group was a set of nine stone sleepers (group 2296) which had been used as the bedding for a tramway track. The stones were of Pennant sandstone and all had the remains of an iron pin for mounting the rail. Measuring pin to pin, the blocks had been set 1.01m apart in two rows, six surviving for the south track and three for the north. This resulted in a gauge of approximately 3 Feet 3inches, rather narrower than the standard 4-foot gauge used for the Penydarren tramway that crossed the bridge at Pont-y-Cafnau (built 1793) but fairly standard for those used in industrial settings from the early 1800s onward. The ghost impression of tracks (Plate 12) survived in the compressed coal surface into which the sleepers had been set (coal deposit 2306). The pattern of sleepers had been interrupted by the insertion of a stone lined box drain or culvert (drain 2301) and a rectangular brick built chamber (2297).

Plate 12. Ghost of the rail that once ran over the south of stone sleeper group 2296. View to south west.

The linear stone box drain (2301) oriented north/south was exposed for a length of 4m (Plate 13) and had originally been filled with a silty, coal dust like deposit (2308). Whilst the overall construction was 1m wide, set into coal dust surface 2306, the internal channel was a square section measuring 310mm by 310mm. The drain was made from Pennant sandstone although there was no obvious bonding material, which may have washed out. The remains of a curving secondary drain 2302, located at a higher elevation and apparently feeding the box drain, were noted. An iron lintel had been set into the east wall of the box drain to support the mouth of a channel that fed into the rectangular brick chamber (2297) located 1.2m to the east.

Plate 13. Box drain 2301 showing the iron lintel covering the drainage channel into rectangular chamber 2297. Secondary drain 2302, which probably Fed the box drain, can be seen curving at the bottom of the image. View to north east.

Box drain 2301 had been deliberately blocked by the insertion of a number of yellow refractory bricks and a spread of compressed coal dust (2303). The purpose of the blocking is unclear but it may have been an attempt to prevent backflow towards the south from the secondary drain area.

The rectangular chamber located east of the box drain measured 1.37m long by 1.13m wide and had a depth to its brick base of 0.85m. It had been constructed from yellow refractory brick bonded with coal rich, grey lime mortar and was oriented north east/south west. The drainage channel from box drain 2301 entered the chamber 0.38m below the top of the south west wall. The north and south walls of the chamber had been raised by the simple expedient of adding a row of bricks, laid edge on (Plate 14). This arrangement may have been to accommodate an iron plate or similar as a cap for the chamber, but still leaving one edge open; there was a suggestion that only the south west side had originally been open, based on distinctive curving at the edges of the bricks which suggested continuous water flow.

Plate 14. Brick chamber 2297. Note the raised edges and distinctive curving in the bricks forming the right hand (south western) side of the chamber. This suggests that this side was open when in use. The dislodging of the lower wall in the image was historical wear and tear caused during its lifetime. View to south east.

Two iron stained Pennant sandstone blocks had been used to form the north west and south west corners of the top of the chamber although the purpose for the change of materials is unknown. The base of the chamber consisted of 12 bricks laid flat, and the interior was stained with coal dust, some of which was compressed and very difficult to remove (Plate 15).

Plate 15. Interior of brick chamber 2297 showing the drain in the south west face and the floor.

The actual function of the arrangement of drains and chamber is slightly problematic. Rectangular chamber 2297 may well be one of the rectangular features shown on the annotated map of the coke yard area done by Mr Cope Pearce in 1856 (Plate16).

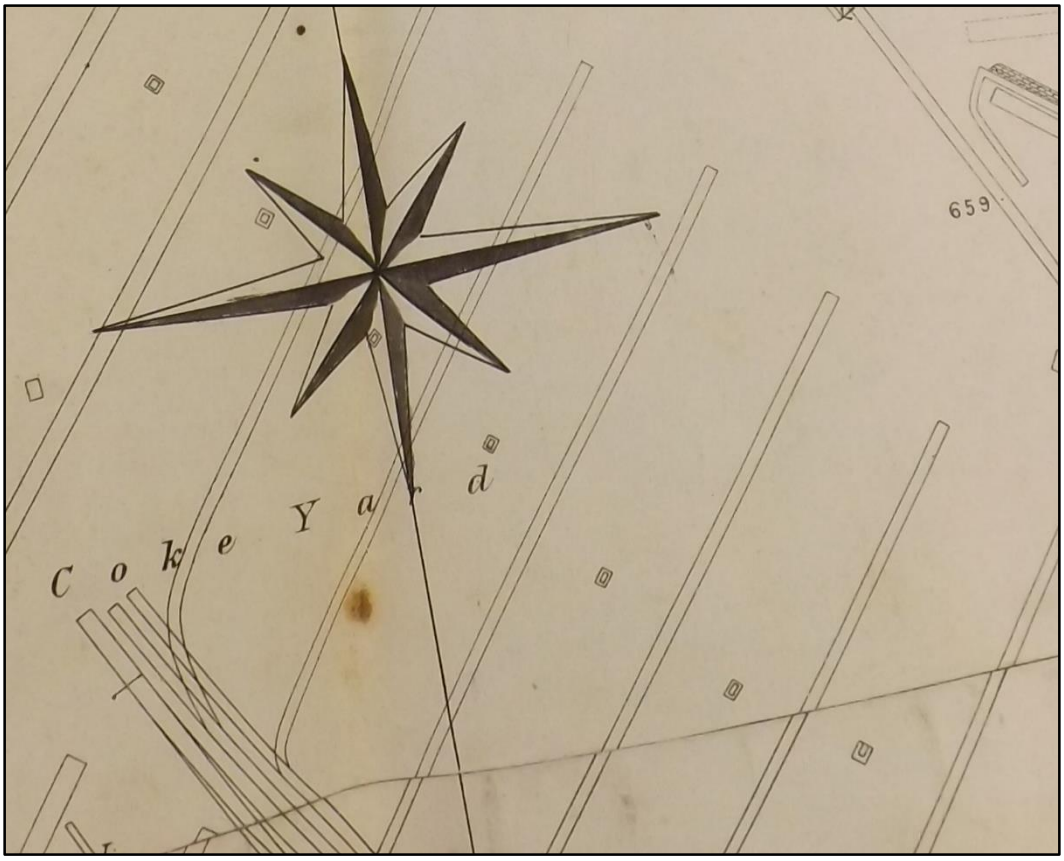


Plate 16. Extract from a map of the Cyfarthfa works of 1856 showing small, rectangular structures within the coke yard. These share the alignment of brick chamber 2297 and at least one is shown with an open end. The linear alignment suggests that a buried drain (such as 2301) may have linked them (Glamorgan Archives DG/F/9/10) One of these is likely to be brick chamber 2297.

These features are shown on the map to be centrally located between tram or rail tracks, and suggests that sleeper group 2296 pre-dates 1856. The features are almost certainly related to the continued production of coke through coking in piles, despite the existence at the same time of the Thomas ovens (see below). By the mid-19th century, coking in piles was generally undertaken using a methodology developed from 1768 onwards by the ironmaster John Wilkinson at Bradley near Bilston in Staffordshire. Wilkinson also produced coke at the New Willey Company's Broseley Ironworks near Coalbrookdale. John Wilkinson was none other than the son of Isaac Wilkinson, who as business partner of John Guest who hailed from Broseley in Staffordshire, leased mineral rights in Merthyr Tydfil from the Earl of Plymouth and laid the foundations of what would become the rival Plymouth iron works.

Charles Wood frequently comments in his diaries concerning the business contacts between the Plymouth works and the nascent Cyfartha iron works and this personal connection means that the technique for coking in heaps pioneered by John Wilkinson would almost certainly have been known and may have been in use at Cyfarthfa from the very beginning. However, there was no evidence of significant quantities of heat or burnt material in the vicinity of the

surviving chamber. Neither did chamber 2297 resemble in any way, previously documented examples of the structures associated with coking in heaps (Jackson 2008). However, all coking required prodigious quantities of water in order to arrest combustion of the coke and the clear associations of the chamber with drain 2301 suggest that the features actually related to the supply and use of water for this purpose. It is possible that each of the brick chambers acted as a reservoir supplied by drain 2301. As the channels gradually clogged with coal dust, additional channels, such as 2302, may have been constructed to augment the flow, with remedial work such as blocking being carried out to compensate for the changes. Contrary to previous belief, there is no evidence from the map of 1856 for the existence of beehive ovens, and it is likely that Cyfarthfa transitioned somewhat slowly from coking in heaps. Indeed, according to Paul Jackson, the technique of coking in heaps was retained, probably out of necessity, at some locations in Britain until after the Second World War, and there is every likelihood that both methods were employed contemporaneously at Cyfarthfa until the construction of the Coppée ovens in 1882. A similar transition appears to have occurred after the construction of the Coppée ovens in 1882, when a battery of the earlier Thomas coke ovens appears to have been retained in use (see below).

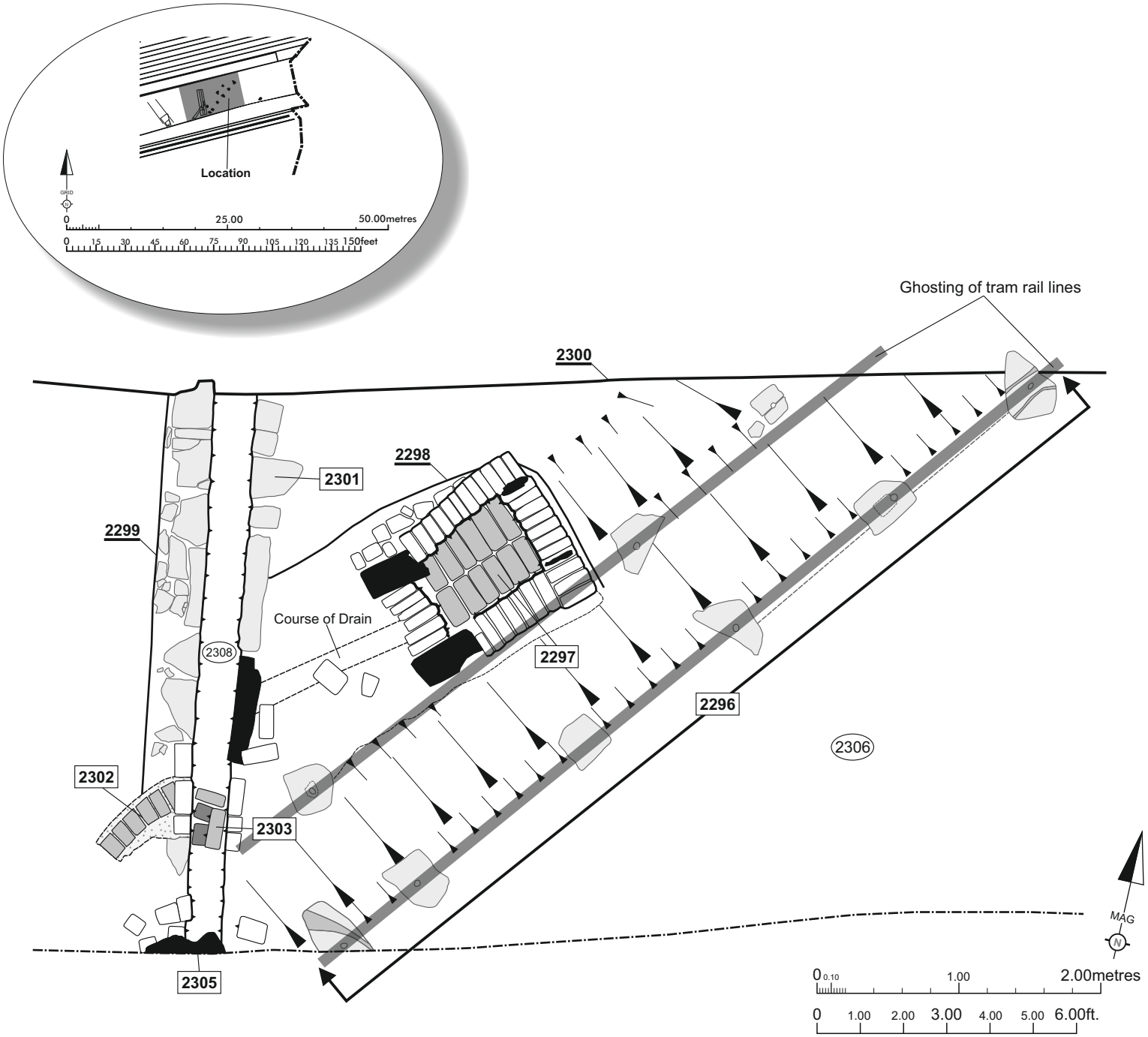


Figure 4. Plan of tramway 2296 and drain features 2301, 2303.

Mine yard

No evidence of a tramway or other transport system was noted in the area of the first phase mine yard with the exception of the remains of the canal itself. The 1795 estate map depicts a forked tramway entering the mine yard from the south west, with the descriptor "a rail to bring mine to the yard from Ynusfach [sic.]". A single lime kiln is depicted at the eastern edge of the mine yard and it is possible that the 'L' shaped remains of a wall uncovered towards the end of the excavation may be associated with this feature. The wall was built of Pennant sandstone blocks bonded with hard light grey mortar (Plate 17).

Plate 17. Smithy area, 'L' shaped structure showing the steps and the inner return of the 'L' shape. View to north.

The blocks had been shaped but were unworked and had been laid in somewhat irregular coursing, surviving in places up to an exposed height of 1.2m although the wall was certainly higher. A set of eight stone steps (Plate 17) had been constructed at the inner angle of the 'L' but there would originally have been more as the top of the wall had been truncated. The steps were a later addition, butting up to the wall but not bonded and the outer face of the stairs was angled, either to add stability or, less probably, to act as a buttress. The highest quality stonework incorporated in the wall was associated with the short length of the 'L' shape (Plate 18). Some care had been taken to select and work stones into quoins to produce neat 90 degree angles at the corners but the rationale for the markedly greater effort taken at this point is

unclear. This section of the wall has the appearance of a buttress but the structure beyond this point remained un-excavated.

Plate 18. Smithy area, L shaped structure, showing the batter on the steps and the better quality stone quoins to the right of the image. View to east.

There are no obviously corresponding structures indicated on cartographic sources that help in the interpretation of the above wall. A conventional lime kiln is likely to have had a more solid construction and indeed the estate map shows it as a solid looking square structure. However, the construction and appearance of the wall has more in common with that of the canal than other structures within the site and it is likely that in date, at least, it has its origins in Phase 1 or Phase 2 of operations at Cyfarthfa.

Phase 1 summary

Although highly fragmented, there was evidence for the operation of the Cyfarthfa coke yard from some of its earliest days. The discovery of a section of Anthony Bacon's canal was unexpected as it had largely been forgotten since the 1840s. Its presence corroborates later documentary information that materials were brought in by tub boats pulled by people and is broadly similar to those employed in Shropshire around the same period. The canal appears to have been retained as a source of water after it had largely been superseded by the railway through the construction of a culvert within the channel. However, no evidence of how that water was removed from the canal and utilised was found. It is possible that the infilling of the canal and construction of the culvert represents nothing more than a dual effort to remove what

was in effect an obstacle dividing the coke yard, and to contain the flow of water within the canal, which would otherwise be difficult to divert. As the canal was reputed to have been in use until the 1840s, the culvert work must date to the mid-19th century and more properly belongs to Phase 2. The main surviving section of stone tram road sleepers possibly also date to this period; they are certainly one of the earlier features noted on the site and circumstantially may be related to a tramway noted on the 1795 estate map of the Cyfarthfa works.

The 'L' shaped wall noted towards the end of the archaeological work may relate to the presence of an early lime kiln but not enough was exposed to be certain. No artefacts datable to Phase 1 were recovered from the site.

All phase 1 features were reburied following recording with the exception of the possible limekiln wall, which was subject to preservation by record.

6 Phase 2. Circa 1840 to 1882

Based on cartographic differences between the Board of Health Map of 1851 and an annotated map of 1856, it is quite likely that a group of coking ovens, based on a specific design principle and known as Welsh or Thomas ovens, were constructed between these dates, representing a technological shift in the operation of the iron works. The storage areas depicted on mapping at the west perimeter of the site appear to have become redundant or at least significantly less utilised around this time. Other features appear to have been retained, however; the fact though that the rectangular chambers associated with the former coking yard are depicted, as well as the retention of extensive area of tramway suggests that coking in long piles may have continued in use either as an interim or a supplementary means of producing coke. Certainly, John Percy (1875) stated in his treatise on Metallurgy that he had seen coking in long piles "practiced largely at Cyfarthfa, Lowmoor and elsewhere." As Percy had visited these sites in the 1850s and 60s this clearly suggests that use of both the ovens and piles were contemporaneous (see Phase 1 above).

Thomas ovens

The remains of a row of early coking ovens were found beneath the north wall of the north battery of Coppée coke ovens. These remains shared an alignment with coke ovens depicted on mid-19th century cartographic sources and which had been demolished to make way for the Coppée ovens constructed in 1882. The 1851 Board of Health map of Merthyr Tydfil depicts the coke yard area but does not depict these features; a map of the Cyfarthfa works dated to 1856 does show them. This strongly suggests that the ovens were built in the five years between 1851 and 1856. The recorded remains consisted of a series of brick floors showing extensive heat damage, with limestone elements located at the peripheries and at the southern elevation of the row. Several 'D' shaped iron fittings are likely to have been stays that indicated the position of a door mechanism. The internal divisions between each chamber were visible as damaged areas of brickwork but none of the divisions survived above floor level. There was evidence that the coking bench, *i.e.* the working surface where hot coke was pushed/pulled out of the ovens and doused with water to arrest combustion was located on the south side of the ovens. No evidence was noted for the presence of a steam rammer on the north side of the ovens although contemporary sources (Percy 1875) state that the coke at Cyfarthfa was indeed pushed out of the coke ovens by a "suitable apparatus, capable of being moved on a railway along the back of a single row of ovens". It must be assumed that the pusher mechanism and rails were removed on demolition of the Thomas ovens.

Thomas ovens were described by John Percy in his treatise on metallurgy as one of a number of non-recovery oven designs in use at the time but all ovens of this type were essentially an intermediate technology bridging the gap between coking in piles, beehive ovens and the later more massive coke ovens introduced in the 1860s and 1870s. Thomas ovens are sometimes referred to as Welsh ovens as their development appears to have been conducted primarily in South Wales, where for a time they appear to have been the dominant form of coke oven. Relatively little is known about the operation of Thomas ovens, for the simple reason that they were a transitional technology and as far as is known, the Cyfarthfa examples remain the only Thomas ovens to have been examined archaeologically.

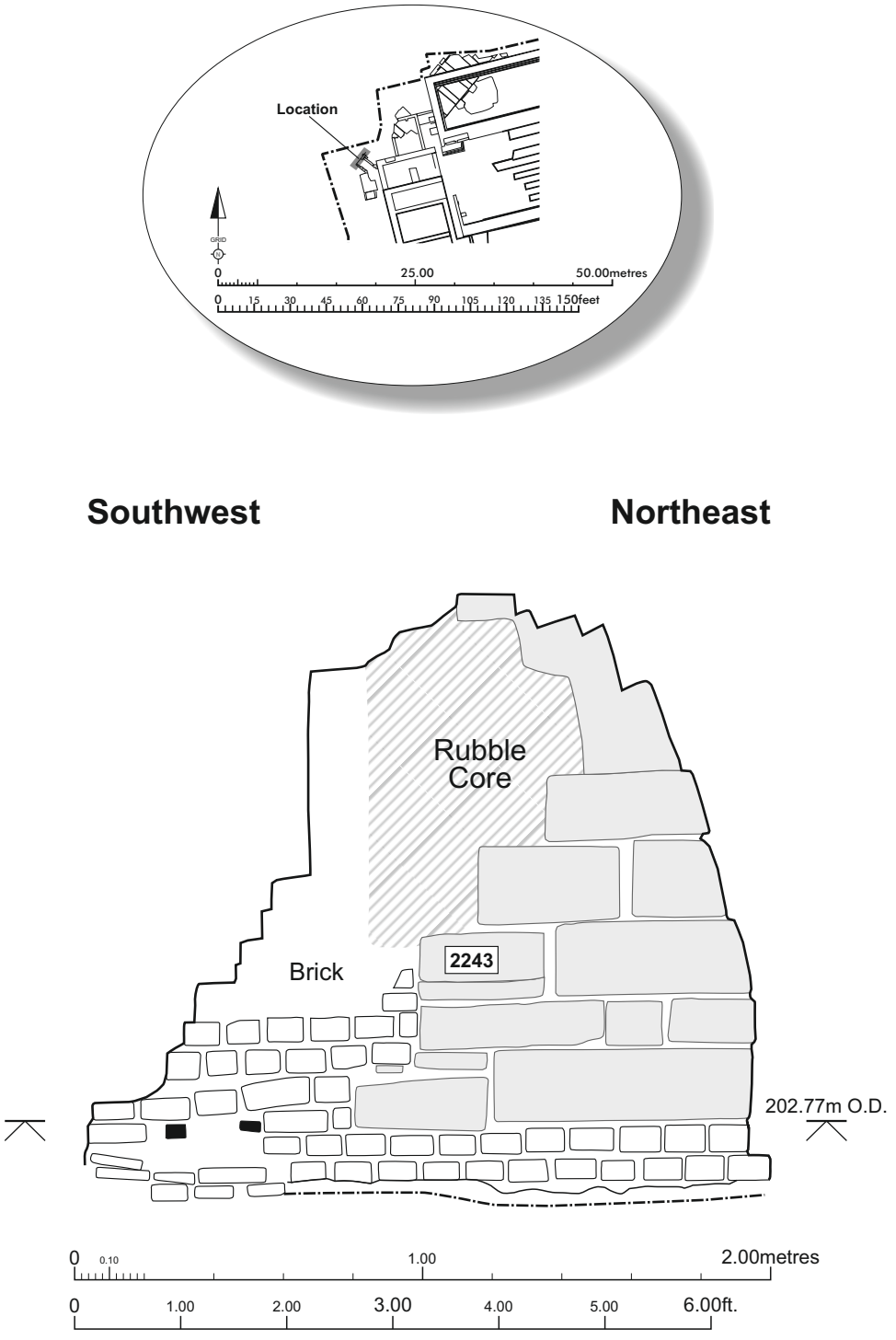


Figure 5. Gable end of the Thomas oven.

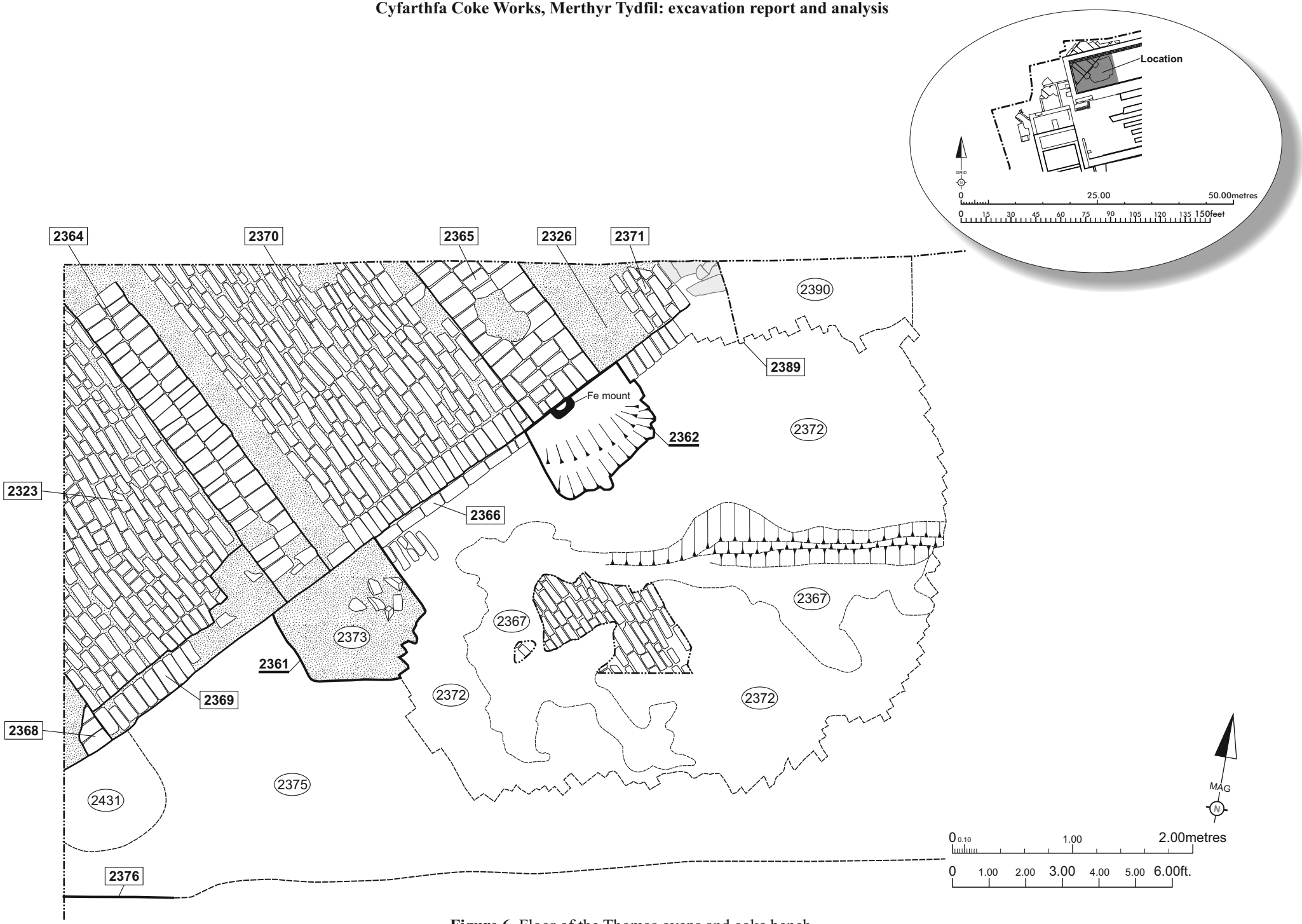


Figure 6. Floor of the Thomas ovens and coke bench.

The most substantial recorded part of the Thomas ovens to survive was a section of the south west gable end of a battery of ovens, made from pennant sandstone (2243). This exterior wall had a length of 3m north to south, a width of 1.15m and survived to a height of 1.7m. It had been constructed of large, squared stone blocks, with the one surviving corner possessing stressed quoins with a hammer dressing to the stonework. The wall had a batter on the south west elevation whilst being flush on the opposite side (Plates 19 and 21), a characteristic which is visible in a drawing of a Thomas oven in John Percy's work. The stones had been laid on a foundation of two courses of yellow refractory brick and the north (interior) elevation of the wall consisted of brick which was keyed into the stone wall to a height of at least 0.4m. The whole structure was bonded with a soft textured, light grey/white lime mortar elevation. The bricks of the interior elevation were vitrified, indicating the presence of high heat. A 'D' shaped iron fitting (Plate 20) had been built into the foundation course 1.45m from the corner and appeared to have been positioned in the centre line of the dividing wall between each interior floor. A number of identical fittings were found in the same position along the exposed length of the ovens and they were almost certainly used as stays to support upright door fittings, none of which were recovered.

Plate 19. Battered gable end of the surviving element of the Thomas ovens. Note excellent quality of the dressed stonework.

The actual reason the gable end was retained is something of a mystery but it may have acted as a buttress for elements of the later Coppée ovens.

Plate 20. Close up of the 'D' shaped stay associated with the door fittings on the Thomas ovens.

Plate 21. View of the surviving corner of the Thomas oven

Three individual, separate floors to the ovens were uncovered (2369 to 2371) (Plate 22, Figure 6). Each had been constructed of brick laid stretcher pattern and bonded with a coal rich lime mortar. These floors appear to have survived as they were buried within the footprint of the later Coppée ovens and although highly truncated, it was clear that they were originally rectangular in plan. The width of each floor was slightly inconsistent, 2369 being 1.78m

(5'10"), 2370 being 1.74m (5'8") and 2371 being 1.4m (4'7"). This width is considerably narrower than that depicted by Percy (shown as being 7'6") although he often admits elsewhere in his works that his depictions are the theoretical ones rather than reflections of actual practice. Only the length of 2369 and 2370 could be measured (4.53m or 14'10"and 4.55 m or 14' 11" respectively) and again this is considerably shorter than Percy's reported length of 36'. There was, however, a fall in the elevation of the floor surfaces from north west to south east, from 202.452m to 202.329m OD in the case of floor 2370, and from 202.411 to 202.329m OD in the case of floor 2069. This corresponds to a 5inch fall in the elevation which reflects almost exactly the 1:36inch fall in the floor suggested by Percy to aid removal of coke from the Thomas oven. Another point of agreement with Percy's description is of the use of red brick in construction of the flooring as this was believed to be less prone to wear and tear from the dragging of coke and coal than yellow refractory brick. Although yellow refractory brick was used in the construction of the foundations of the ovens, the wearing surfaces were all of red brick (Plates 25-27).

Plate 22.View to the south west of the internal floor surfaces of the Thomas ovens. The internal divisions are marked by the absence of bricks whilst the coking bench is the damaged brick surface to the left of the ranging rods. Slot 2366, a recess for the coke oven doors can be seen immediately right of the ranging rods. The upstanding walls are the remains of the later Coppée oven which was constructed in the 1880s.

A deliberately engineered slot (2366) was noted separating the coking bench and oven floors. This slot was made from red brick and measured 1.53m long, 0.12m wide and 0.04m deep. Its purpose is likely to have served as a recess to accommodate the bottom of the coke oven door (Plates 23 and 24). A rectangular pit had been constructed either side of slot 2366, which following excavation of the rubble that had filled them, proved to be construction pits for parts of the uprights of a door mechanism. Each pit (2361 and 2361) measured 1m by 0.72m and was excavated to a maximum depth of 0.8m below the oven floor level. 'D' shaped iron fittings were noted built into the oven walls (Plates 23 and 24). Unfortunately, the evidence is not

indicative of whether the doors were of two leaf design, opening outwards as depicted in Percy, or whether they were of one-piece construction sliding vertically as seen on a number of photographs of similar ovens in operation in England. It is unclear as to whether the pits would have been left open during operation of the ovens but it is considered unlikely, as to do so would have constituted a hazard. The pits may have been covered by timber, or more likely filled with the rubble that was removed to expose them during the excavation.

Plate 23. Receiver pit 2361 for part of the Thomas oven door mechanism. Note the iron stay, identical to those on the north side of the ovens.

Plate 24. Receiver pit for door mechanism showing slot 2366 for the door. View to west

Plate 25. View to the north west of the interior of the Thomas ovens.

Plate 26. Interior floors of the Thomas ovens and coke bench showing the relationship with later brick chamber 2341. View to east.

Plate 27. North side of the Thomas ovens beneath the later Coppée coke ovens. View to south.

Coke yard remains

Very few remains associated with the Phase 2 coke yard appeared to survive, as later development had all but obscured any features. It is evident from cartographic sources that there was an extensive rail network into the yard, the remains of which certainly survived into the early 20th century. Unfortunately, nothing of this network was noted during the excavation, with the exception of the comparatively small area of earlier stone sleepers discussed under the first phase activity, and the assumption must be that all traces were removed during de-commissioning of the works. The compressed coal working surface into which the Phase 1 tram road tracks and other features were inserted appears to have been subsequently buried by a build-up of more coal and coal dust. The evidence for this comes from the cut that was made for the insertion of a pair of inspection chambers (2341 and 2309 contained by cut 2310) that appear to relate to phase 4 and may be associated with the Thorn Electrical works. Cut 2310 was made into a deep deposit of coal dust and was clearly visible in section (Plate 28).

Plate 28. Cut 2310 and inspection chamber 2309. These features were cut into a coal dust surface which appears to have built up over the phase one levels and may be an indicator of the original level of the phase two marshalling yard. View to south east.

Culvert group 2295

A pennant sandstone culvert featuring a low arch was noted as having been cut into coal surface 2306 and sealed by an orange coloured clay. The stones were bonded with light grey lime mortar and the arch had been formed by skilfully placing the stone slabs edgeways, as voussoirs (plate 29).

Plate 29. Coke yard area, culvert group 2295 showing the highly distinctive orange clay (deposit 2347) used to seal the culvert. Considerable quantities of coal dust (deposit 2306) must have been present at the time the feature was constructed. View to south.

The culvert was found beneath the footprint of the north coking bench and was aligned north/south and had an internal height of 0.75m and internal width of 1.05m. In section the roof was slightly triangular in shape, with straight sides and a flat base. The feature had a stone floor (Plate 30) and contained three separate fills, (deposits 2350 to 2353) all of which were characterised as silty coal dust, and occasional ironstone, and believed to have been deposited through water action; several courses of stonework appeared to have suffered the effects of water erosion and there were traces of clay lining the upper part of the culvert chamber.

The use of the orange clay was unusual and it has been speculated that it was used either to help prevent the lime mortar from washing out or as an early form of warning indicator to highlight the presence of the culvert below in the event access was required. The southern, unexcavated element of the culvert lay beneath part of the north Coppée oven coke bench (specifically brick trough 2202) whilst the northern section had been truncated by the construction cut for the north Coppée oven battery (cut 2300).

Plate 30. Coke yard area, stone floor of culvert 2295. Note the traces of clay on the upper stone courses.

Combined with a complete absence of brick from the structure, the form and phasing of culvert group 2295 is suggestive of a relatively early date, certainly falling within Phase 2 of activity on the site or possibly Phase 1. The fact that the culvert had been inserted into an already extensive coal dust deposit suggests that it may have originated in the mid-19th century but in the absence of firm dating evidence this is speculative. The purpose of the culvert is unclear but the prodigious quantities of water required to 'water' *i.e.* arrest combustion of coke would have necessitated an extensive network of culverts and group 2295 may have been part of this system.

The Smithy

Plate 31. View towards the Cyfarthfa Coke works taken around 1891. The low building to the right of the prominent spoil heap is the smithy building (courtesy of Cyfarthfa Castle Museum).

The building within the development area known variously on maps of the area as the smithy or forge is depicted on both the tithe map and the 1851 Board of Health map and corresponds to one depicted continuously on Ordnance Survey mapping up to the Third edition OS map of 1919. It is quite likely that the building was destroyed as part of the wider demolition of the works commissioned in September 1924 as the building does not appear on the fourth edition OS map of 1938 and the building appears absent from an aerial photograph of the area dating to 1930 (RCAHM WPW032573). The smithy is shown as a long rectangular building on cartographic sources and is variously described as a 'forge' (1851 Board of Health map) and 'smithy' (Ordnance Survey mapping) although the difference in terminology is not thought to be reflective of a change of function; indeed, these sources show the building retained its essential external form and therefore probably its function through several phases of the operation of the Cyfarthfa works. There was little evidence of obvious phasing in the excavated remains although admittedly, relatively little had survived. The smithy building is partly visible on a photograph dated 1891 (Plate 31) which shows a chimney at the east gable end and at least five chimney stacks built above the south wall of the building. This suggests that there were at least five hearths within the building, with the east gable chimney possibly being of a more domestic nature for a hearth in an office or store room. The photograph suggests the presence of a doorway of outbuilding close to the north east corner but no other windows or openings are visible, these most likely being located on the north side of the smithy.

A subsequent photograph of 1920 shows the walls of the building intact but the roof being absent, suggesting it had not been in use for the period of the temporary re-opening of the works during the First World War.

Plate 32. Remains of the smithy/forge building as exposed, view to south west.

The smithy building was partly exposed for a length of 16.8m during the development work in order to assess the extent of its survival and to record the remains prior to re-burial. The excavation revealed that only the lowest portions of the foundation walls survived, together with the highly truncated remains of three hearth bases, which had been built against the inside of the south east wall. The building had a width of 6.6m. There was no evidence of internal division within the building with the exception of a rectangular area of brick floor at the north east end of the building (Plates 32 and 33), which would approximate to the area of the gable chimney and doorway noted on the photograph above. Curiously, there was no obvious foundation for a partition wall demarcating the brick floor from the remainder of the smithy and the nature of this internal division above the floor is unknown.

Plate 33. Brick floor surface forming the only internal division within the smithy/forge at the north east end of the building. View to north east.

The remainder of the internal flooring of the smithy consisted of a compressed coal dust working surface. The south west end of the building was not excavated due to the presence of the site boundary and an electricity sub-station and it is possible that this feature truncated the remains of that part of the smithy. The very extreme east area of the building was likewise unexcavated due to being very close to the site boundary and no hearth was noted there despite the photographic evidence of a chimney in the gable end; it is likely this feature remains buried beneath the development. The position of a single doorway was noted within the foundation of the north west elevation in the form of an iron plate used as a possible threshold (Plate 34). The foundation was too damaged, however, to be certain that this was the only doorway or even whether the smithy had been open sided in some areas.

Plate 34. Iron plate forming a possible threshold into the smithy/forge. This was the only obvious entrance into the building although more undoubtedly existed. View to east.

Each of the hearths was constructed similarly, of stone bonded with light grey lime mortar. Brick had occasionally been incorporated in places but the overall effect was to produce a rectangular hearth, 2m wide and 1m deep, built against the inside of the south east elevation of the smithy wall, though not bonded to it. Each of the hearths was separated from its neighbour by a distance of 2.5m. The corners and sides of the hearths incorporated squared off blocks of stone, with the remainder having a much more irregular appearance and using liberal quantities of mortar (Plate 35). The only evidence of fittings was associated with the north east hearth, in the form of a 1m x 0.6m iron plate laid flat adjacent to the north east side of the hearth. The actual function of this plate is unknown. The original appearance of the hearths is speculative but based on similar, surviving examples, each is likely to have been equipped with a hood to remove fumes and smoke, and it is the chimneys for these hoods that are visible in the photograph mentioned above (Plate 31).

A small number of iron bolts, short iron rods and nuts were recovered from the interior of the smithy but these were not associated with any particular feature. The much corroded remains of a spoked, cast iron wheel was also found in the general demolition material around the smithy; these items may have been part of the fittings within the smithy or indeed could have been made or repaired within the facility. The original purpose of such a building would have been the manufacture and repair of everyday ironmongery, as well as probably the manufacture of more bespoke items necessary for the daily operation of the Cyfarthfa Works. The presence of five smithying hearths, three of which were exposed during the excavaton, points to a high demand for such items although it is slightly puzzling as to why such an important building was located on the periphery of the Cyfarthfa site. It is possible that it was located to serve both

the main blast furnace area and the lower works, as it was fairly central for these two areas. Additionally, it may have been convenient to site the smithy close to large supplies of fuel.

Plate 35. Remains of the best preserved hearth base. Along with two others, this is all that remains of the smithying stations that would have been in operation every day at the Cyfarthfa works. View to east.

Archaeometallurgical residues

No archaeometallurgical samples were recovered from the site of the Cyfarthfa coke works. This almost certainly reflects the fact that the activities which would have produced them were undertaken on the lower levels of the main ironworks to the east and north east. No such material was noted in the vicinity of the smithy, which was the only location at which one might have reasonably expected such activity to be carried out. However, the level of truncation was such that any remains could easily have been missed; in the absence of the original floor level, even residues that would have been simply lying on the floor appear to have been removed.

Miscellaneous structures

The corner of a structure (2249 and 2250) and a stone capped drain (2248) were noted lying beneath the walls of the northern range of storage bunkers (2213) (Plates 36 and 37).

Plate 36. Walls 2249 and 2250 which had been cut by the construction of storage bunker wall 2213 for the coke works. Note also box drain 2248 which terminated at the corner of the structure.

Plate 37. Stone capped drain 2248 may have been cut by the construction of walls 2249 and 2250; the exact nature of the relationship was unclear. This view towards the north east shows the fair faced interior of the structure.

Mr. Cope Pearce's sketch of the Cyfarthfa works dated to 1856 (see conclusion) depicts a rectangular structure that appears to be partitioned into at least six separate parts and it is possible that walls 2249 and 2250 are part of this building. They are shown as being more extensive on the earlier 1851 Board of Health map and are labelled as storage areas but it is clear that this area of the works was in a state of flux over this period.

Wall 2130

This truncated linear wall was of similar appearance to walls 2249 and 2250 although it was located further south and on a different alignment (north west to south east). The wall was 7.82m in length and survived to a height of 0.53m above the excavated ground level (Plate 38). It had been built of un-coursed pennant sandstone bonded with mid grey coal flecked lime

mortar and possibly some clay, resulting in a wall width of 0.77m. The wall is truncated both north and south by insertion of the Coppée coke ovens and crusher, indicating that the wall originally dated to before 1882. However, nothing more can be said regarding this feature other than it may relate to the series of storage buildings noted on the Board of Health map of Merthyr Tydfil and Cope's annotated plan of the works, both dating to the 1850s, as discussed above.

Plate 38. Phase 2 wall 2130, truncated by the construction of the 1882 washing and crushing plant. View to north west.

Stone tramway sleeper group 2384

A series of five stone tramway sleeper stones were located within the footprint to the north Coppée coke oven rammer wall (2323 to 2326). The sleepers were aligned north east/south west in two parallel lines (three and two stones respectively Plate 39). The stones were of pennant sandstone set into a compressed coal dust surface (2399) and were spaced apart sufficiently to create a gauge of 1.18m (3ft 7 inches). Each of the highly irregular blocks had a single circular hole drilled to presumably accept a retaining pin for the rail system. No iron staining was visible on any of the blocks and no other remains associated with the tramway appeared to have survived.

Plate 39. North Coke rammer wall area, the remains of a Phase 2 tramway (sleeper group 2384) which had survived beneath the fill of the rammer wall. View to north west.

Phase 2 summary

The physical remains dating to Phase 2 were highly fragmented due to the nature of later development on the site, specifically the construction of the Coppée coke ovens in 1882. The complete lack of artefactual evidence associated with specific features makes interpretation and dating of features highly dependent on available cartographic and documentary sources, and the only relatively accurate dates established for Phase 2 are those for the Thomas ovens, which, from available mapping, date to between 1851 and 1856. The remainder of the recorded features, such as the masonry walls and tramway sleepers, are generally too fragmentary to establish more than broad phasing and it is possible that some elements may in fact be earlier, dating to Phase 1.

Despite a previous belief that beehive style coke ovens may have been in use at Cyfarthfa, no physical evidence for such structures was noted, and indeed, contemporary evidence from Percy, who had had actually visited Cyfarthfa in the mid-19th century fails to mention the presence of beehive coke ovens, although he does refer to both the Thomas ovens and the continuation of coking in long piles. As for all archaeology, the absence of evidence is no indicator of evidence of absence, yet on balance, it is unlikely that beehive ovens were employed at Cyfarthfa. Features probably relating to the supply of water to the coke yard were noted, as were the remains of a transport system in the form of the tramway sleepers; the vast majority of these systems were swept away by construction of the Coppée ovens in 1882.

6 Phase 3. 1882 to 1926

The majority of the area excavated as part of the archaeological works was dominated by the remains of the coal washing and coking plant. A number of historical documentary sources have been located that aid interpretation of the remains, and the salient points of each are repeated below.

The Cyfarthfa works was extensively remodelled, beginning in 1882, to facilitate its conversion from an iron works to a steel works. As part of this modernisation programme, a new coking plant was installed, to replace the Welsh or Thomas ovens that had been used since the first half of the 19th century, a move which also presumably marks the end of the use of coking in long piles at the Cyfarthfa works. The operation of this new plant, built over the original coking yards, is extensively described in an 1897 booklet (Crawshay Brothers (Cyfarthfa) 1897) which is essentially an advertising prospectus released as part of the re-branding of the Cyfarthfa works after its conversion to steel production. The section concerning the coking plant is informative and is worth quoting in full.

"Coal Washing and Coking Plant – The Coal Washery is an exceedingly efficient plant, and gives very great satisfaction. It deals easily with over 500 tons per shift, and the mixing, sizing and washing of the coal are all that can be desired. The loss of coal due to washing is under 5 cwt. per 100 tons, while the refuse is very completely eliminated, reducing the ash in the coke to a minimum.

A noteworthy feature of the plant, which otherwise possesses much in common with modern coal washing plant, is the settling chamber, which dispenses with the usual settling ponds with their attendant trouble and expense in cleaning out; enables the water to be used over and over again, and to which is due the very small amount of waste. The nut and pea coals on leaving the washing machines, pass through a screen perforated to allow the water to escape through to the settling chamber, and are elevated to a Carr's disintegrator, where they are reduced to a powder, and fall to the foot of a second elevator where they meet the duff coal from the settling chamber, and the whole of the coals thus reduced to the required fineness, are raised to extensive storage bunkers capable of holding about 600 tons of clean coal, fitted with distributing screws, by means of which the coal is taken to whichever part required filling.

The arrangements at the coke plant are very complete. The ovens are of the Coppée type in two banks of 90 each, and are fed with washed coal from the storage bunkers by means of conical dandies which pass underneath the bunker, and are filled by means of slides in the bottom of it.

The dandies have sliding bottoms, through which, when open, the coal drops into the ovens. Each oven is capable of making 10 to 11 tons of coke per week. The charge of coal per oven is 2 ½ tons generally, in the proportion 1/3 bituminous coal and 2/3 steam coal, and the time of coking 24 hours. The average weekly make of the total 180 ovens is about 2000 tons.

The coke is pushed out of the ovens by means of powerful steam ram engines, carried on travelling carriages which can be brought opposite to any particular oven. The coke is conveyed to the blast furnaces from the coke bunkers by means of dandies, several of which are placed on a low truck worked by wire ropes and a small engine, and drawn under the bunkers to be filled under sliding doors arranged for this purpose. After they are filled the truck is withdrawn and the dandies are brought back to a point level with the top of the furnaces, to which they are brought direct.

The waste heat and gasses from the ovens are utilized under 10 boilers for generating steam for driving the washing, crushing and distributing machinery at the washery and ovens, and brickworks, blast engines at the blast furnaces, and other contiguous machinery."

The original technical drawings for the construction of the ovens have not been located and it is not known at the time of writing whether the work was undertaken internally or whether, as is more likely, an external company was responsible for the construction of the Coppée ovens. Despite a large number of bricks recovered during the excavation being marked with the names of external contractors (see brick analysis report below), the same prospectus that described the coke plant also makes it clear that the works was equipped with a highly advanced brickworks, constructed at the same period as the Coppée ovens, capable of an output of 20,000 bricks per day of both red and firebrick type. Besides the manufacture of these bricks, "tuyéres, seats, stoppers, and pipes are made for the use in the Bessemer department, and bricks for lining the blast furnaces, for the Cowper stove regenerators, and for the coke ovens, all of special size or form, are also made by machinery, effecting a great saving of labour as compared with hand making." This makes it clear that whilst an external contractor may have been brought in for the initial build, which is likely to explain the variety of 'imported' specialist bricks, the Cyfarthfa works was eventually more than capable of supplying itself with the specialist bricks necessary for the continual operation of the coke ovens.

The form of the Coppée ovens, laid out in two parallel batteries, is also worthy of note. According to Paul Jackson of the Coke Oven Managers Association,

"In the period 1882-6 there was constructed at these works [Cyfarthfa] a unique structure comprising of two batteries of 90 Coppée coke ovens. Unlike Ebbw Vale where a similar number of ovens were placed in-line, the batteries here were built so that the coke-side of each faced inward to form a rectangle. They were located west of the ironworks and formed an immense structure. Coke from the benches was stored in a central row of bunkers, below the benches, from where it was loaded into 'dandies' and onto an incline plane, to be conveyed to the furnace tops. The stonework was again massively constructed with ornate trimmings (to chimneys etc.) and this coking complex was unique in the United Kingdom. Unfortunately, up to this point in time, no useful pictures which could throw more light on the various details of this temple-like structure have surfaced."

Subsequent research has demonstrated that several photographs do actually exist of the plant (Plates 31 and 40) but the layout of the Cyfarthfa Coppée ovens was indeed unique within the United Kingdom.

Coppée coke ovens

The coke ovens were constructed to operate on the Coppée principle and were constructed as part of the modernisation of the works and its conversion to steel making. To quote Paul Jackson,

"Originating from continental Europe, as many of the nineteenth century coke oven developments did, the Coppée oven was the invention of Evence Dieudonné Coppée, a Belgian coking works manager. He took several of the continental types of ovens and modified them to produce a horizontal chambered oven with vertical heating flues and a door at each end of the chamber. Most importantly he organized the ovens in pairs so that each would be at a different phase of the coking cycle at any one time. This enabled coal, in a freshly charged oven, to be quickly brought to coking temperature by intense heat from the walls, which were heated with gas created from the second oven, which would be in the middle of its coking process and producing a plentiful supply of fuel."

The exact date of construction for the oven and washery/crusher complex remains unknown as no documentary references specifically recording this fact have been located at the time of writing. Although Coppée introduced his method in 1861, Jackson believed that the ovens dated to between 1882 and 1886 and most sources state construction of the new plant, with its

attendant coke plant, began in 1882. This means that, like the Bessemer converters, the Crawshay Brothers were installing technology that was already 20 years old.

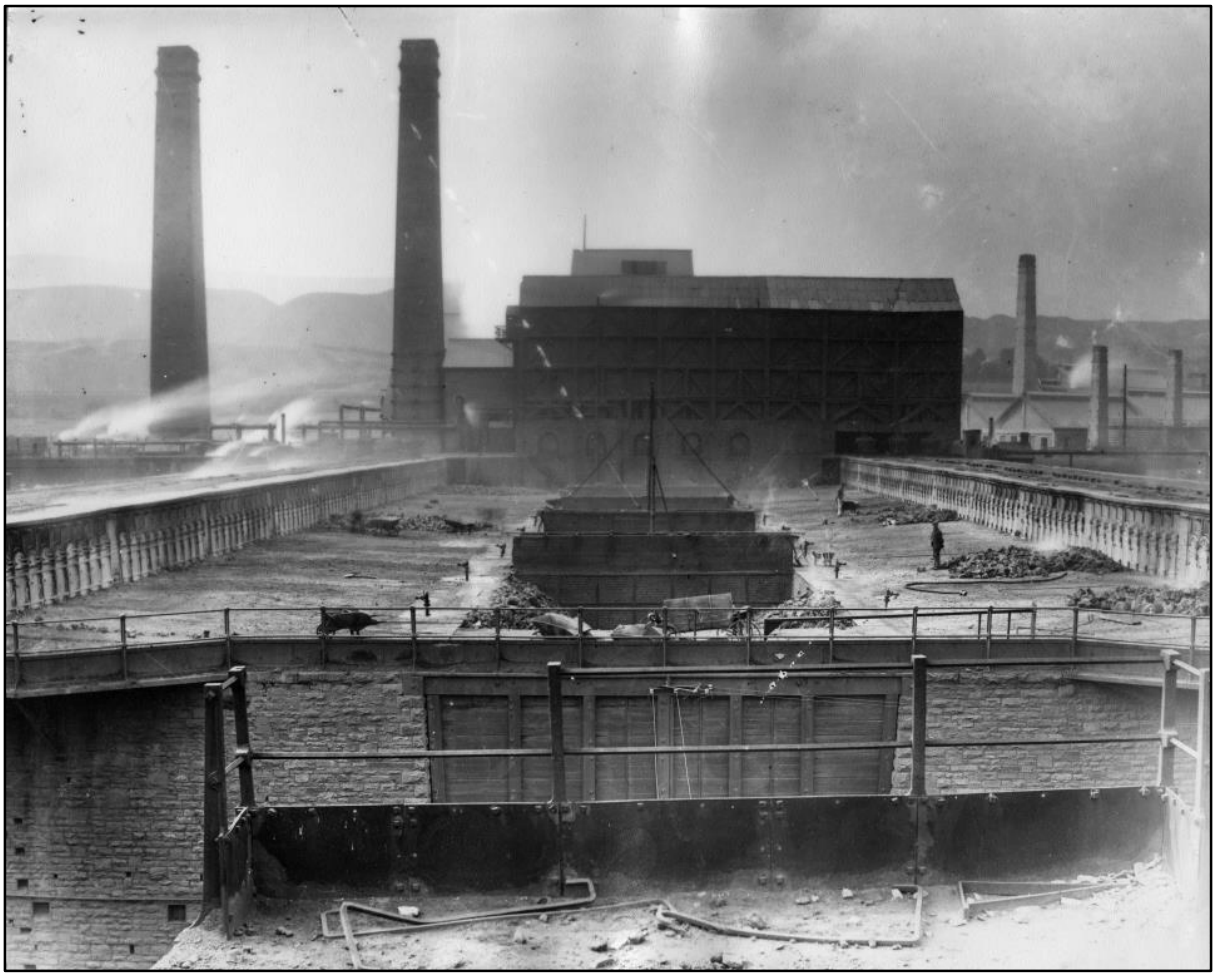


Plate 40. The only known specific photograph of the operational Cyfarthfa coal washery and Coppée coke ovens, believed to have been taken in the early 1890s. View to west. The photograph is full of detail but highlights that fact that the excavated remains comprise only a fraction of the original site. The building and chimneys visible in the top right of the image is the brickworks (Alan George).

In 1894/5 the crushing plant was modified through the addition of a Sheppard Feldspar washery system. This installation appears to have supplanted the Carr's disintegrator originally installed on construction of the ovens in 1882, but which was, nevertheless, retained. It is unclear whether a dedicated washery was originally built as part of the coke plant but the addition of the Sheppard washer a decade after initial construction suggests that it was thought to be more efficient to prepare the coal close to the ovens than close to the collieries, as had been done in earlier periods (see below). Both these phases were visible and have been divided for convenience into two sub-phases in this report, Phase 3a dating to 1882 and Phase 3b dating to 1894/5. Although they would have been operated as an integrated whole, for convenience the washery and crusher are described separately from the coke ovens.

Coal washery and crusher

In order to produce good quality coke, it is necessary to ensure that the coal used in the process is of an appropriate type and is free of contaminants like stone and mud that could otherwise

interfere with the coking process. In order to obtain the required level of purity, it is necessary for the coal to be cleaned (known as washing), and graded, to separate out stone from the coal and to ensure that the coal is of a relatively uniform size, using mechanical means. In the case of Cyfarthfa, the nature of this operation during the earlier period is unknown. Pedler mentions a screen (another term for a washery) located near Colliers Row Pit, located approximately 600m south of the Cyfarthfa site, when discussing the old Cyfarthfa Canal (1930 p.26) but the context of the reference is somewhat unclear. It seems likely, however, that much of the processing undertaken later at the excavated washery was done off site during the first two phases of the works. Neither the Board of Health map of 1850, nor the 1856 map of the works, contain any indication of a washery or similar and the conclusion must be that the coal was indeed washed and sorted away from the site prior to the erection of the Coppée ovens and attendant washery.

This sequence of processing does not seem to have been retained for the Phase 3. The prospectus for the Cyfarthfa Works published in 1897 makes it clear that the only raw material for which the works was not self-sufficient was iron ore, which whilst formerly obtained from the Cyfarthfa estate, was derived at that time chiefly from Spain. Coal was therefore still being obtained locally and it was probably more efficient to have a centralised, modern washery, although this may not have been realised for some time.

The first crusher with a Carr's disintegrator at the heart, was constructed in 1882, at the same time as the Coppée ovens. Young (Appendix II) states that this was largely supplanted in 1894/5 by a Sheppard Coal Washer, his source being a contemporary industrial magazine known as The Engineer of 1895. One stipulation of the contract to construct the new washery was the retention of the Carr's disintegrator in order that it could be used rapidly in the event of the new machinery malfunctioning. The Bridgend firm of Sheppard and Sons Ltd. was employed to construct the washery to a design of their development. The excavated remains exhibit features from both sets of plant, and although only the remains of the Sheppard plant are generally recognisable, the two phases are discussed below.

The excavated remains of the washery and crusher represent only the very lowest levels of the original structures. The photograph of the coke and washery complex taken in the 1890s (Plate 40) clearly demonstrate that much of the plant was housed in a substantial raised, brick, stone and iron clad superstructure. However, enough of the foundations of the washing and crushing plant survived to assign functions to each of the areas.

The first phase crusher, centred on the Carr's Disintegrator, is depicted on an annotated map of the works prepared by the Chief Engineer in February 1892 (Plate 41). This shows the layout of the washery and crusher buildings as well as the coke oven complex. The purpose of the map was primarily to indicate the location of various steam engines and their water supplies rather than to detail the layout of the plant itself. The building housing the crusher is labelled 43 and described in the accompanying schedule as a 'coal crushing rolls engine' As the contract for the later addition of the Sheppard Washer specified the retention of the disintegrator, elements of the first phase should be visible and indeed it appears they are distinguishable by the use of different coloured brick, evident in the excavated remains.

Plate 41. Annotated map of the Cyfarthfa coke works dated 23rd February 1892. This shows the Coppée coke oven complex in its original form (Phase 3a), prior to the addition of the Sheppard Washer in 1894/5. The red features are the locations of individual steam engines (Glamorgan Archives DG/F/9/10).

Table 1. Schedule of engines for the Cyfarthfa coke plant Phase 3a (see Plate 41)

No.	Description	Specification	Notes
43	Coal crushing rolls engine	Two 12-inch cylinder horizontal engine. 18 inch stroke	
72	Feed pump blast boilers	Single 5½-inch cylinder vertical inverted engine. 6-inch stroke	
40	Disintegrator and elevator engine	Single 26-inch vertical inverted engine. 30-inch stroke	Base excavated
42	Archimedean screw engine	Two 8-inch cylinder vertical inverted engine. 9-inch stroke	
41	Coke haulage engine	Two 10-inch cylinder horizontal engine. 12-inch stroke	
67	Coke push out engine No.1	Two 8-inch cylinder horizontal engine. 10-inch stroke	Destroyed
68	Coke push out engine No.2	Two 8-inch cylinder horizontal engine. 10-inch stroke	
74	Feed pump (Cameron)	Two 5½-inch cylinder vertical inverted engine. 6-inch stroke	Unexcavated.

Phase 3a

Carr's Disintegrator elevator pit

The Carr's disintegrator was an item of plant invented by one Thomas Carr for the crushing and sorting of a variety of materials, including coal. In the case of the Cyfarthfa coke ovens, the design involved placing washed coal within contra-rotating iron cages where it was pulverised and mixed to the required grade, before dropping out of the machine into a chute from where it was transported using an Archimedes screw into storage bunkers, prior to being loaded into the coking ovens. Only the elevator pit for the disintegrator had survived as a series of substantial, yellow refractory brick built chutes, forming an inverted, rectangular pyramidal shaped pit. The pit had been filled with demolition debris but sufficient was removed in order to permit recording of much of the feature. The feature was not given a group number during the excavation and it will simply be referred to as the disintegrator elevator pit in this report.

The disintegrator elevator was contained within a broadly square building constructed in the main from yellow coloured refractory brick bonded with hard grey lime mortar, but including pennant sandstone elements, bonded using the same type of mortar. The north (2064) and south (2065) chutes had been rendered with hard mid-grey mortar in order to create a smooth surface.

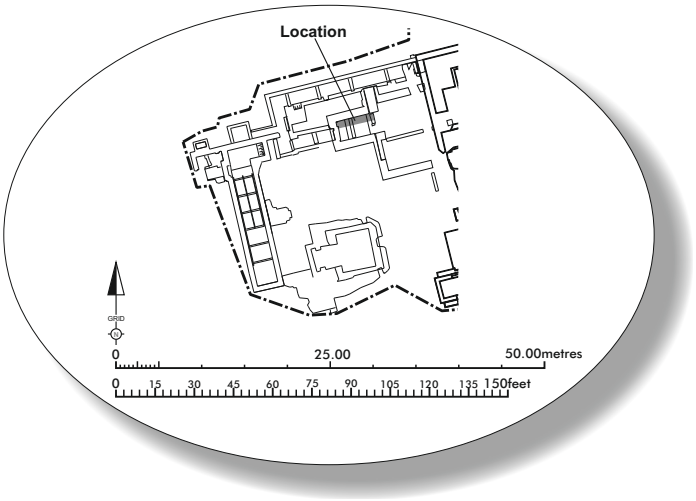
Plate 42. The western elevator chute 2063 for the Carr's disintegrator. Note the parallel lines on the far wall marking the position of the iron sheets that formed the actual wearing surface of the elevator. This sheeting was intact at a lower level, as seen at the bottom right of the photograph. View to north.

The main, western chute had originally been provided with a series of timber beams set into the brick, onto which iron sheeting was nailed or screwed, in order to provide a smooth wearing surface. This system was damaged but still present at the lower level of the chute (Plate 42).

The whole of the structure appeared to have been sunk into the ground and the sides supported by means of a number of retaining walls (2014, 2015, 2069, 2126, 2127, 2101, 2102 and 2103).

The largest chute into the elevator pit was the western one (2063), which appears to have provided direct access from the coal washing area (Plate 43). This may have been the case for the first phase of operation but the technical drawings contained within the 1895 Engineer publication suggest this area had been bypassed when the Sheppard system was introduced; it is possible that this chute was retained as part of the requirement to switch to the original system in the event of a failure in the Sheppard plant. Chute 2063 was exposed to a length of 5m and was 2.43m wide. It had been skilfully constructed of yellow refractory brick, bonded with hard, dark grey mortar, and the resulting slope dropped 2.3m from the top to the bottom of the excavated surface. Two slots for timber sleepers had been created during construction of the chute, one of which was still in place. The slots were 0.5m wide and 0.08m deep and spanned the width of the chute (Figure 7).

Plate 43. The western chute 2063 for the Carr's disintegrator elevator. View to west.



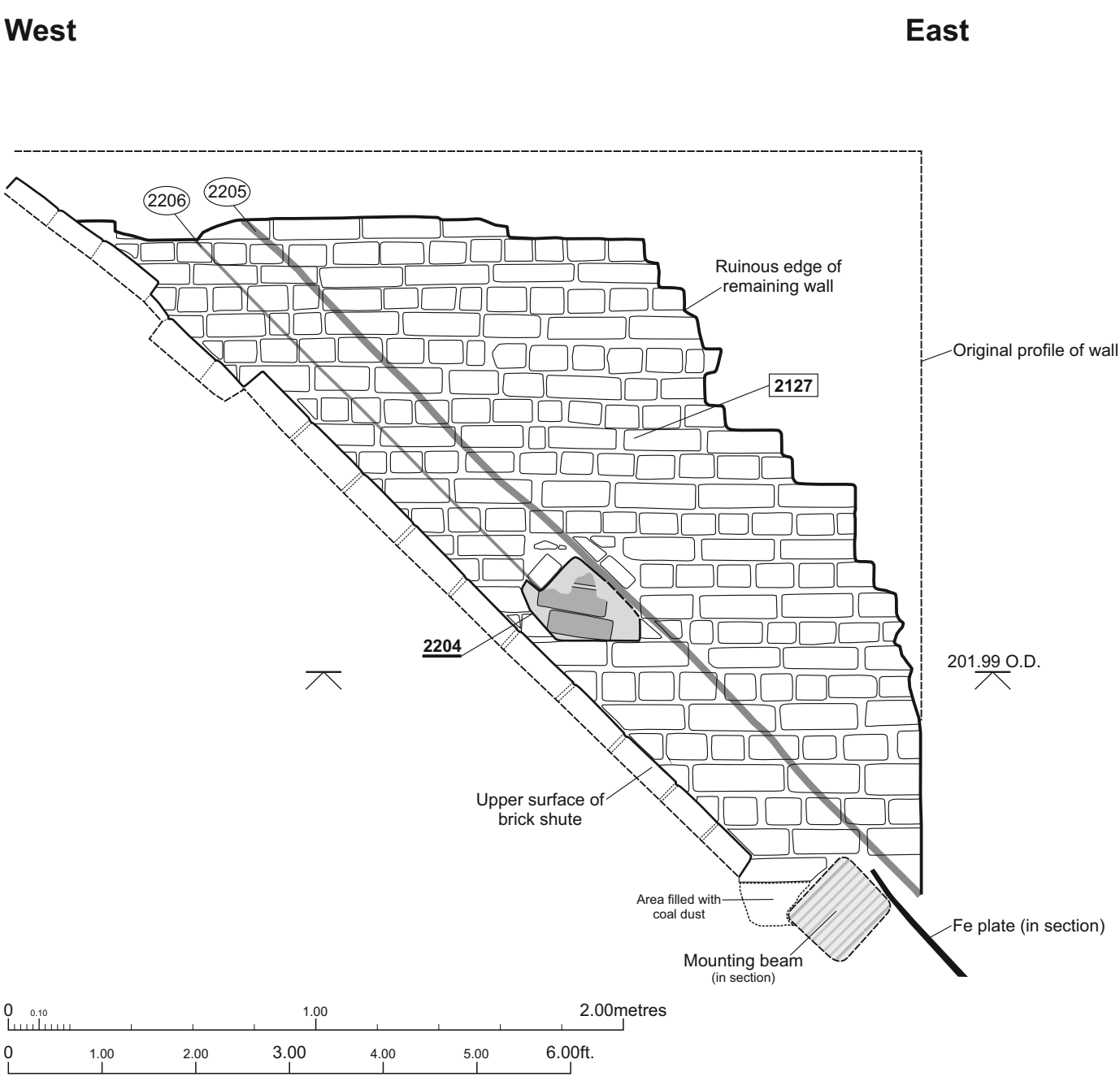


Figure 7. Elevation drawing of the main chute for the Carr's disintegrator.

A second chute (2064) was located in the north side of the elevator pit. It had a width of 1.21m and was exposed for a length of approximately 4m. The upper section of the ramp was visible as a series of yellow refractory brick steps, whilst the lower portion retained the mid grey lime mortar render which had been used to create a smooth wearing surface (Plate 44); it is likely the upper portion was also rendered but this has worn away. Occasional red brick and stone elements were noted although these were isolated and not significant. The elevation difference was equal to the western chute (2.3m) although the angle was more acute, having to drop the same level in a shorter distance.

Plate 44. The north chute (2064) of the Carr's disintegrator elevator pit. View to north.

A third chute was located in the south of the disintegrator elevator pit; chute 2065 was the most unusual of the three, being relatively narrow (0.63m at the minimum) at the upper level and widening out to 1.17m towards the base of the excavated depth. This arrangement produced an 'L' shaped surface to the chute, readily apparent in the photographs (Plate 45).

Plate 45. The southern (2054) chute for the disintegrator elevator pit. Note the reversed 'L' shape which contrasts with the full width of the other two chutes. View to south.

The construction of the southern chute was similar to the northern one *i.e.* it had been built of largely yellow refractory bricks rendered with a hard grey lime mortar to produce a smooth

wearing surface. The chute was 4.45m long as exposed, with the angle being more acute than the western one in order to accommodate the elevation drop in a shorter distance. The purpose of the narrower construction is unclear but it is possible that it may have permitted access to the base of the chute to clear obstacles or effect repairs. Alternatively, the gap may have been to allow passage of pulleys or other items of plant; the location is close to that for the coal crusher roll engine (engine 43 depicted on the above map of 1892 (Plate 41) although little relating to the engine was noted.

A substantial brick build foundation for an engine was located adjacent to the area formerly occupied by the Carr's disintegrator (Plate 46). This foundation was solidly built of yellow refractory brick and measured 3.89m in length by 4.94m in width, being at least 3.5m in height and probably significantly larger when the unexcavated portion was taken into account. The feature contained the remains of six iron mounting pins aligned north west to south east as well as a slot lined with sheet iron which dropped into the foundation for an unknown length. This foundation is believed to have supported engine 40, as depicted on the 1892 map; this engine is described as the disintegrator and elevator engine and is positioned conveniently in between both the storage bunker and crusher areas. It is possible that the slot in the foundation was to permit the passage of line shaft belting or similar means of transmitting the motive power generated by the engine.

Plate 46. Foundation and mounting pins for the disintegrator and elevator engine. View to north east.

Storage bunkers

As in the case of the washery and crusher structures, two phases of storage bunkers were noted during the archaeological work. The first (Group 2172), almost certainly dating to 1882 (Phase 3a), consisted of a rectangular Pennant stone built structure divided internally into four equally sized chambers (Plate 47). The structure measured 19.55m in length, 8.65m in width and in general, survived to an excavated height of 1.55m. The western walls of the first phase bunker

(2175 and 2176) were 1m thick, whilst the others varied between 0.6 and 0.65m in thickness. The additional strength that would have been imparted by additional width on the western side was probably to help support the weight of any plant projecting from the crusher area. Part of the eastern wall (wall 2181) also formed part of the coke storage bins located immediately to the east (see the central coke bin section below) and on excavation this section of the wall proved to have a height in excess of 5m. Wall 2181 merely abutted the remainder of the group (Plate 48) and in fact was part of the substantial single phase construction of the walls of the main, central coke bin. This arrangement confirms that the 2172 group was built at the same time as the coke oven batteries and had no earlier phases.

Plate 47. Phase 3a storage bunkers showing the internal division into four. Note the Phase 3b extension to the bunkers as the red brick walls in the distance. View to north.

Plate 48. Phase 3a coal storage bunker group 2172. Abutment of walls 2176 (left) and 2181 (right). View to east. The slot (recess 2192) in wall 2176 is believed to be a beam slot to support a floor level, working in conjunction with the step in the walls visible in the photograph.

Each of the four internal divisions measured 8.7m long by 3.2m wide and had been filled with a demolition deposit of stone, brick and coal rich loamy material, and isolated iron objects. This deposit was almost certainly the result of the demolition of the bunker in the 1920s, obscuring the original floor level within the bunker. It is quite likely, however, that the structure originally contained raised floor levels as three beam slots were located within the building, together with a stepped foundation on the internal elevation of the bunker walls (see Plate 48). The surviving contemporary photograph of the outside of the structure shows that it once had considerable height and it is reasonable to expect that some evidence of this may survive, even if the actual flooring did not.

Phase 3b Sheppard Feldspar washer

A Sheppard washing and crushing plant was added to the coke oven complex in 1894/95, with the stipulation that the Carr's disintegrator was to be retained so that the original system could be reverted to "at a few minutes' notice" (The Engineer, December 6th 1895, Appendix III). It is unclear as to whether the original system continued in operation in parallel to the Sheppard plant or was simply an auxiliary only to be used when required.

In general, the surviving structural elements of the Phase 3a washery and crusher appear to have been rendered in a combination of yellow refractory brick and Pennant sandstone bonded

with lime mortar, in contrast to the second phase (3b) which consisted of red brick and some concrete. This fact permits, with a reasonable degree of certainty, the identification of first and second structures.

Phase 3b

Coal hopper

This feature consisted of an inverted brick chamber of pyramidal shape (Group 2055, Plates 49 to 51) and was the means by which coal began its journey through the washery.

Plate 49. General view of the remains of the hopper (Group 2055) for the Sheppard coal washer, view to north

The whole of the surviving element of the hopper was square in plan, with sides measuring between 5.65m and 5.71m long. The west wall of the hopper contained an engineered recess, slightly rectangular in plan, measuring 3m by 2.7m. Two brick and iron supports had been constructed either side of this recess, each being 0.61m long and 0.36m deep. These supports consisted of heavy cast iron boxes, filled with brick and were intended to take the great weight of the east elevation of the building that housed the washery plant, as it spanned the hopper. Originally, a double set of railway tracks spanned the hopper, permitting coal trucks to drop their cargoes into the space beneath. The coal was then scooped up in a chain bucket lift system, for transport to a rotating drum that would loosen and roughly size the coal and thence to the

Sheppard Feldspar washers, which would have actually cleaned the coal. Nothing of these two features remained.

Plate 50. Recess in hopper 2055 showing the iron and brick wall supports on either side. View to west.

Plate 51. Hopper 2055 following clearance of the water and debris that it had contained. This feature is exactly as depicted in a drawing contained in The Engineer of 12th December 1895. The rectangular chamber housed part of the chain bucket system.

Settling chamber (Figures 8 and 9)

Plate 52. Base of the remains of the settling chamber. View to south

The settling chamber was described as the heart of the whole plant due to the very great efficiencies it introduced in the preparation of coal for the coking process. Following its journey through the Sheppard Feldspar washers, smaller pieces of coal were carried by water to the settling chamber with a pit for an elevator at one (northern) end. The small coal and water were carried into this pit for conveyance further along the process. At the same time, a scraper travelled slowly along the base of the settling tank in order to collect any fine particles that had gathered and sweep them as well into the elevator pit. This process meant that the water could be re-used again and again as the particulates were constantly being removed; it furthermore meant that the settling chamber never had to be cleaned out (unlike virtually all other contemporary coal washeries) as the scraper did this automatically as part of the process.

The remains of the settling chamber (Group 2051) consisted of a red brick floor, 14.01m long and 2.2m wide, flanked by two parallel red brick walls (Plate 52). The floor was divided into seven separate sections, each divided by a timber beam measuring a standard 0.15m x 0.24m (Contexts 2112 to 2117) at floor level that spanned the width of the chamber. The location of each beam corresponded to a recess in the flanking walls which probably related to structural elements of the scraper system. The length of the floor equates exactly to the 45 feet mentioned

in the 1895 article for the length of the chamber. Three iron strips were found overlaying the sleepers, running along the length of the chamber, one at either edge and one down the centre; none of the strips were intact and it is thought that other sections must once have run the entire length of the chamber, possibly serving as spacers between the brickwork and plant or even as a wearing surface for the scraper mechanism, although there was no sign of undue wear and tear on either the floor surface, beams or iron strips (Plate 53).

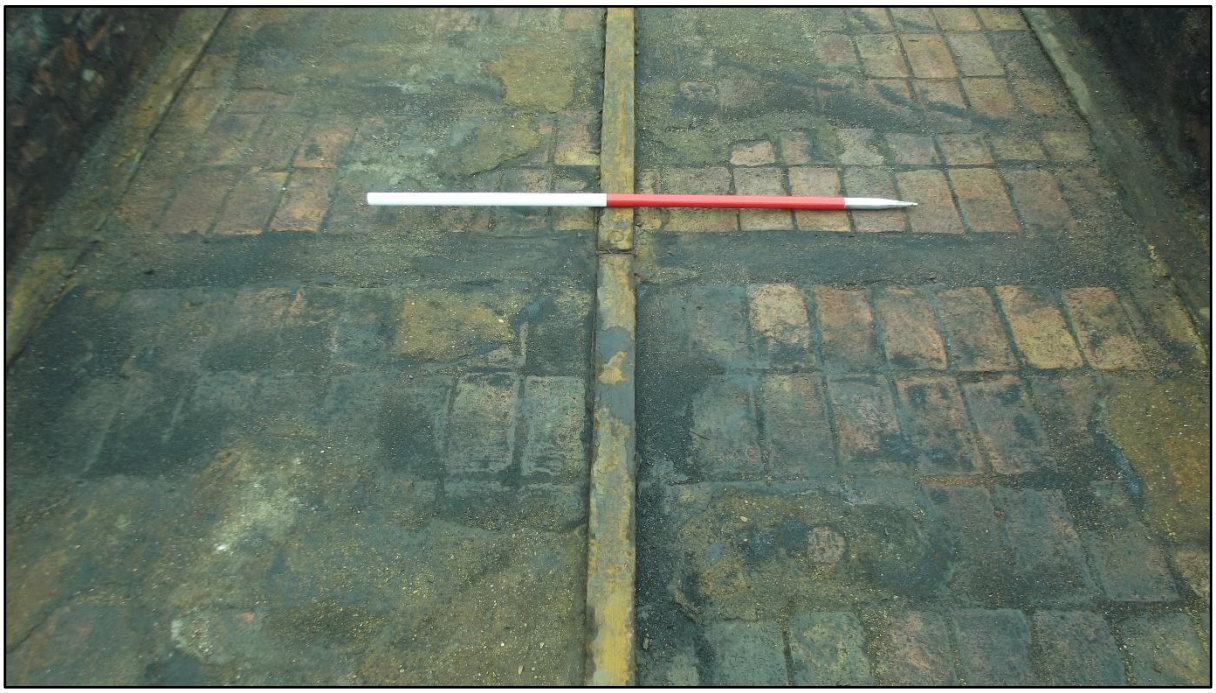


Plate 53. Closer view of the iron strips on the base of the settling chamber. They had been secured to the timber sleepers by round flathead nails. Scale is 1m.

The north end of the chamber dropped away down a chute that appeared to have been rendered with concrete to produce a smooth surface. This chute led into an elevator pit (2049) which was full of water and demolition debris. This pit was 'L' shaped and measured 4.22m by 2.25m. A second concrete rendered, 1.53m wide chute was located at the east end of the elevator pit, at a lesser gradient to the feed chute from the settling chamber. A ceramic overflow pipe (2118) 0.16m in diameter, had been built into the north elevation of the pit, feeding into a brick built chamber (2038). According to the 1895 description of the operation of the plant, this elevator pit was always kept filled with water, hence the requirement for an overflow pipe. Chamber 2038, which also had two other pipes connected to it must therefore have been part of the water recycling system. The depth of the chamber is unknown as the fill (2039) contained visible asbestos and was therefore left unexcavated.

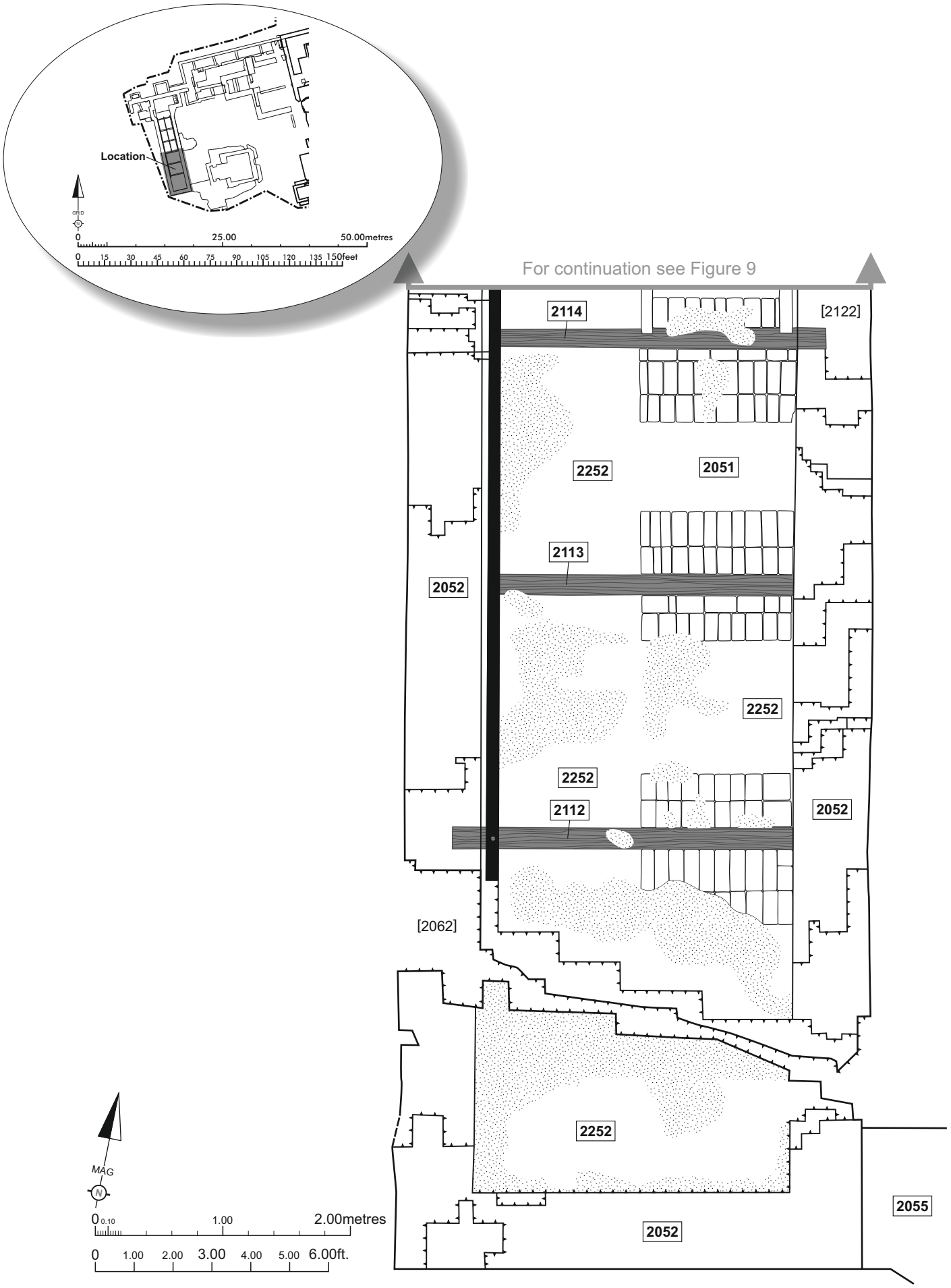


Figure 8. Southern end of the settling chamber.

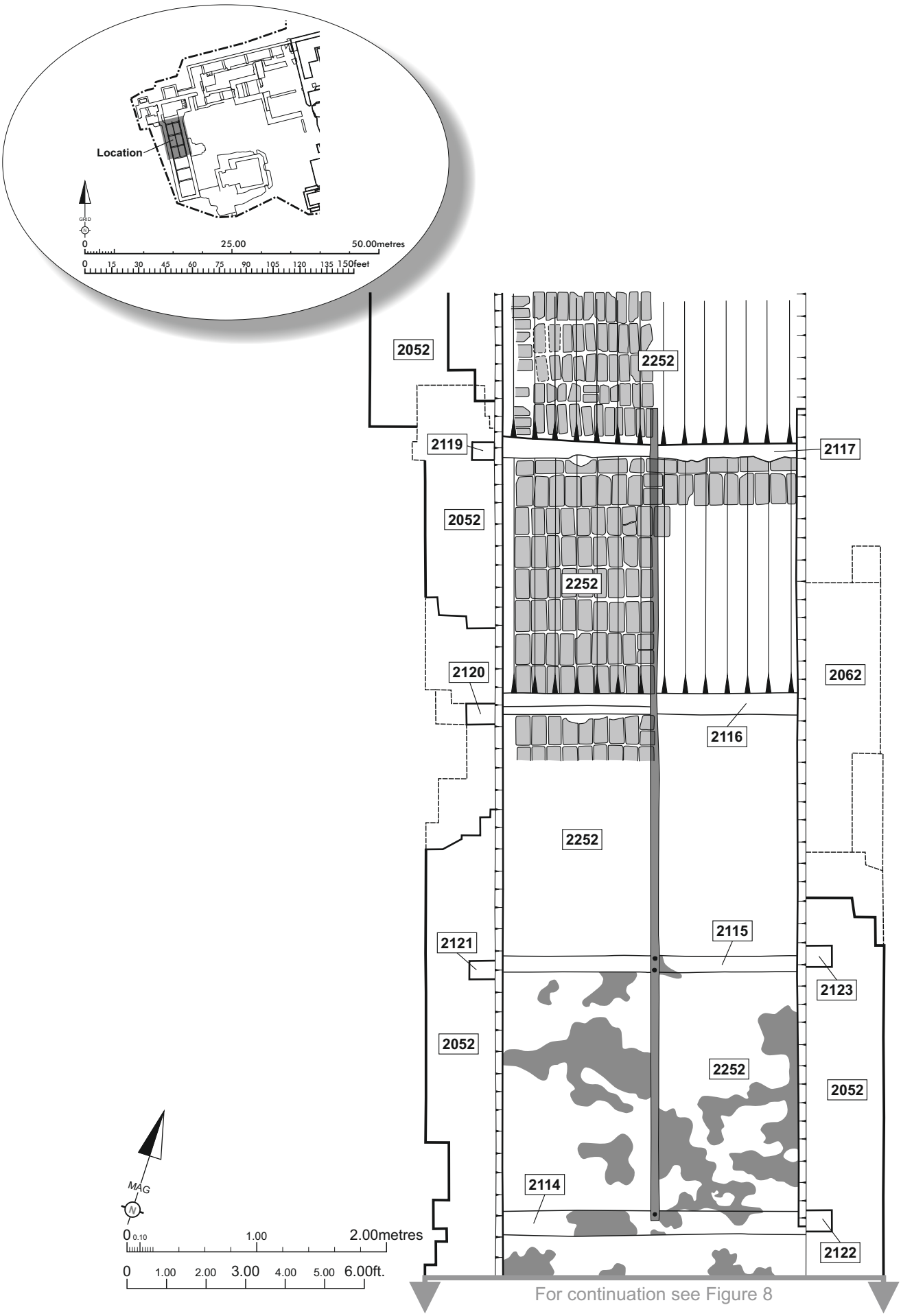


Figure 9. Northern section of the settling chamber.

Plate 54. Sheppard washer chamber 2038, view of the interior, looking south. The chamber contained three pipes, the one from elevator pit 2049, and two others, set lower which are likely to have emptied the chamber. The fill of the chamber (2039) was not excavated due to the presence of asbestos.

A series of truncated red brick walls and floors located immediately west of the settling chamber marks the former location of the Sheppard Feldspar washer. These features (floors 2047 and 2047 and walls 2041 and 2042) are all that remain of the mechanism used to initially wash the coal prior to it moving to the settling chamber. This section of the plant had largely been destroyed, although iron pipes 2125, 2043 and 2040 are probably the remains of high pressure steam pipes used to power the Feldspar washer and possibly to provide the water required (Plates 54 and 55).

Plate 55. High pressure steam or water pipe 2044. This pipe probably helped to supply power or water for the Sheppard Feldspar washer located west of the settling tank and was one of the few remaining elements of it to have survived.

Screw conveyor base (Figures 10 to 14)

After passing through the settling tank, the coal was elevated by mechanical means from pit 2049 towards the east, and along an Archimedes screw contained by a trough, none of which has survived. This system is partially drawn on the 1895 drawing of the washery, labelling it as a "screw conveyor" and making it clear that the excavated remains are the remains of the screw conveyor base. The conveyor trough had been contained within brick built passages, system (Group 2059) consisting of a southern 6.6m long passage (brick floor 2074 and associated walls), and a northern 17.1m long passage (brick floor 2072 and associated walls), oriented east west, and running parallel to each other. The two passages were joined at the western end by a further passage, 6.7m long and running north to south, which also branched to the west (brick floor 2075), allowing drainage into water overflow tank 2038/2039 through a ceramic pipe set at floor level. In plan, all these passages gave an appearance somewhat akin to a tuning fork. Each of the passages was of a uniform width of 1.4m and the two east to west passages contained recesses for timber sleepers, the remains of which were *in situ*. The space between the passages was filled with a combination of yellow grey clay and stone (2058) and the structural remains of a brick base (2060).

2060 was a brick base located between the east/west passages and which incorporated a 0.91m wide chute leading to the north passage from the area of the base (Plates 56 and 57). This chute corresponds to the position of one illustrated in the 1895 Engineer which appears to indicate that the elevator from pit 2049 raised the coal from the settling tank before distributing it to the conveyors contained by both the passages formed by Group 2059.

A number of walls made up the sides of the passages (2090, 2098, 2099 and 2060) all being of red brick construction, bonded with hard, dark grey lime mortar. In general, they survived to a height of 0.65m in six to eight courses of brick. Slots had been built into the inner wall of the passages adjacent to the sleeper recesses in the passage floors to facilitate easier replacement of the sleepers themselves. Wall 2099 had been cut by the insertion of a later ceramic drain, almost certainly associated with the Thorn Lighting works. The northern passage (brick floor 2072) was sloped down from east to west, with a difference in elevation of almost 0.5m. Some slumping of the structure was evident and at its damaged eastern end, it was possible to tell that the whole floor was only one or two bricks thick.

Plate 56. The north passage of Group 2059 (brick floor 2072) showing chute 2060 to the right. Note the sleeper locations and the slots built into the flanking walls that would have permitted easier replacement of the sleepers. Note how the pins are off-set to the right (south) side of the passage, possibly to allow limited access to the screw conveyor for clearing blockages and repairing the machinery (see also Plate 59). View to east.

Plate 57. View of chute 2060 in the north passageway. Note the recess in the wall to the right of the chute to allow for insertion of a timber sleeper. Scale is 1m.

The timber sleepers (2106 to 2110) set within the passage floors were broadly similar in form and dimension. Sleeper 2107, set into the brick floor of the passage (2072) was the most intact and will be described as being representative of the other examples. The remains of 2107 (Plate 58) were 1.25m long, 0.2m wide and 0.16m deep. The sleeper was furnished with four, screw threaded iron bolts close to each corner of the beam. The bolts had square heads and were fitted with square washers to aid securing. The bolts were arranged to be 0.86m apart at either end, and iron staining on the surviving timber suggested that the bolts were a method of securing machinery rather than part of a rail system. The arrangement of the bolts was off-set to the south of the centre of the passage, indicating that the screw conveyor was also offset. This is, in fact, how the arrangement is shown on the 1895 drawing, with the Archimedes screw being shown hugging the south wall of the north passage. It is quite likely that the resulting space on the opposite side would just about have permitted access for clearing blockages or repairing the conveyor.

The east end of the north passage was damaged but ended where it butted up against a yellow refractory brick wall 2129, although the wall in this area had been repaired or blocked using red bricks, suggesting that the screw conveyor may once have extended further to the east (Plate 58). This modification is likely to have taken place as part of the installation of the Sheppard plant in 1894/5 as the blocking is in the same style of construction as the rest of the screw conveyor base.

Plate 58. The damaged east end of the north passage showing the blocking in wall 2129 that dates to Phase 3b (1894/5) and which was done during installation of the Sheppard plant. View to east.

Plate 59. Remains of timber sleeper 2107 set within floor 2072. Scale is 1m. Note the shallow recess beneath the wall on the left of the photograph which permitted insertion of one side of the sleeper; the opposite end could then be dropped into place using the larger recess in the opposite wall.

Close examination of the slot for sleeper 2107 revealed the method for inserting the beam; the slot contained a recess beneath the north wall, wide and deep enough for one end of the sleeper to be pushed into it. The opposite end of the slot corresponded to one of the recesses engineered into the inner walls of the passage, which then allowed the sleeper to be dropped into place. This allowed the insertion of a sleeper which was wider than the passage itself, and which may have reduced movement of the conveyor caused by vibration.

The shorter, southern passage of the screw conveyor was constructed in a similar fashion to the northern one but contained only a single timber sleeper (2077), although a damaged area of the floor may have contained a second.

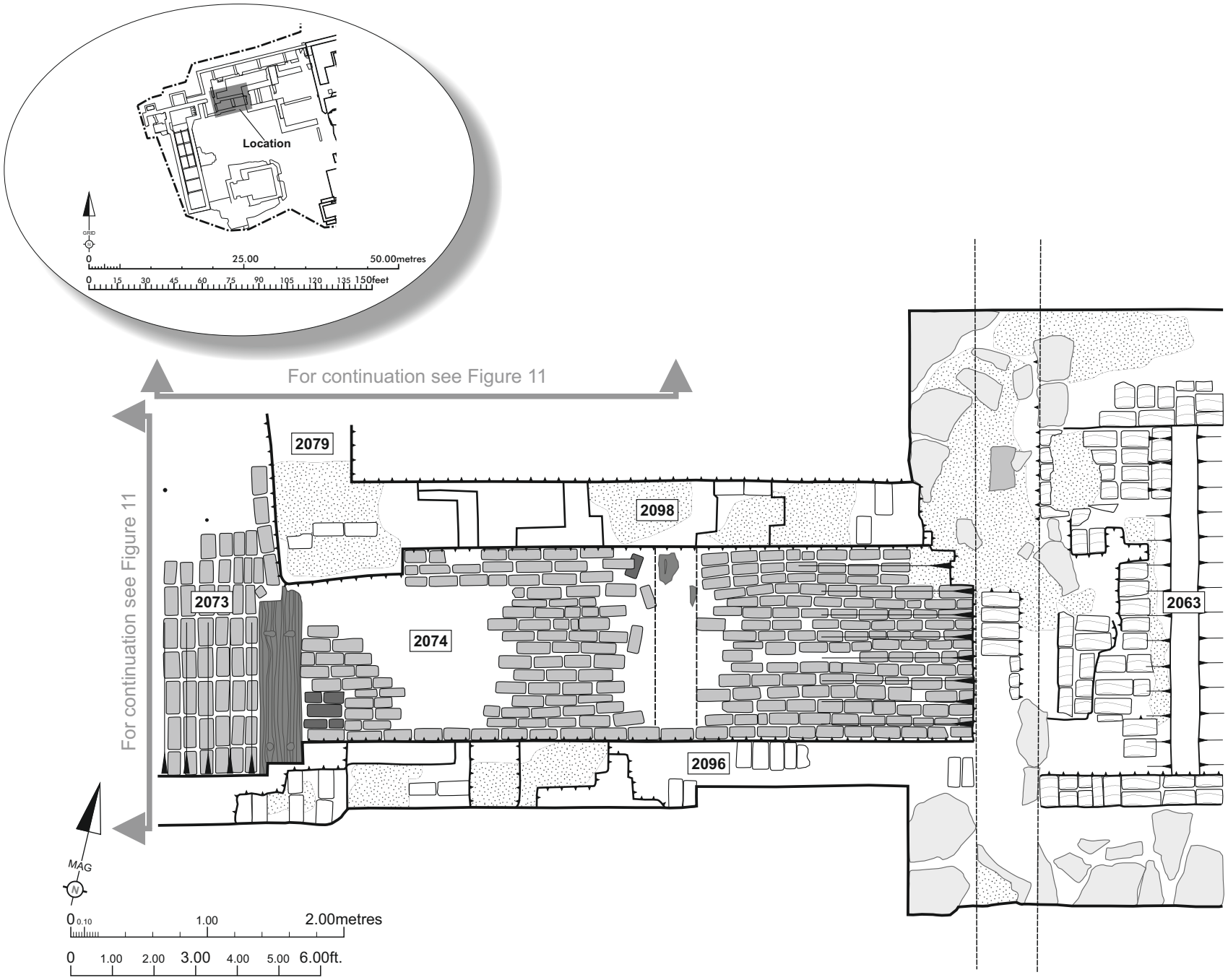


Figure 10. South section of foundation for the distributing screw mechanism.

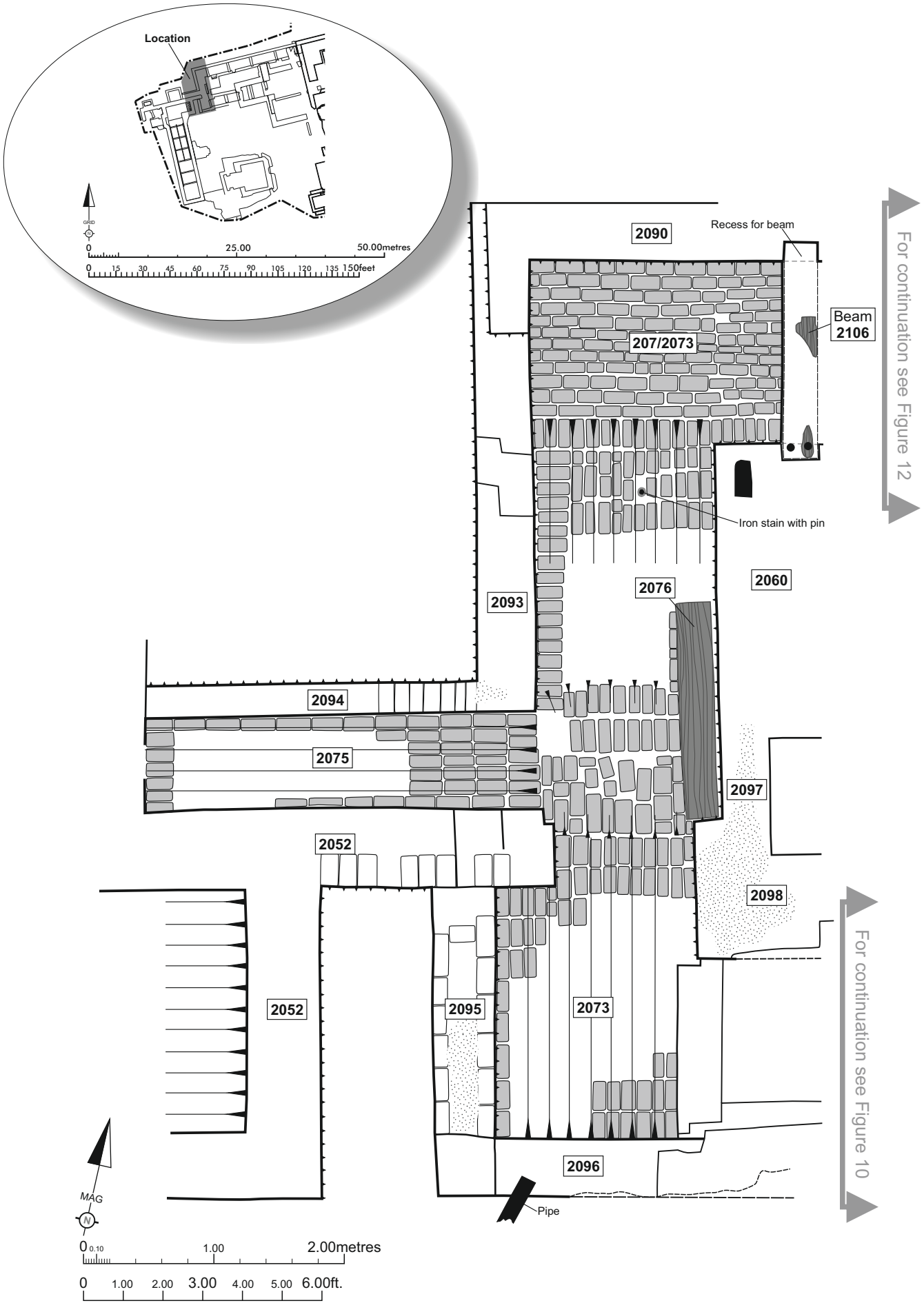


Figure 11. Central section of foundation for distributing screw mechanism.

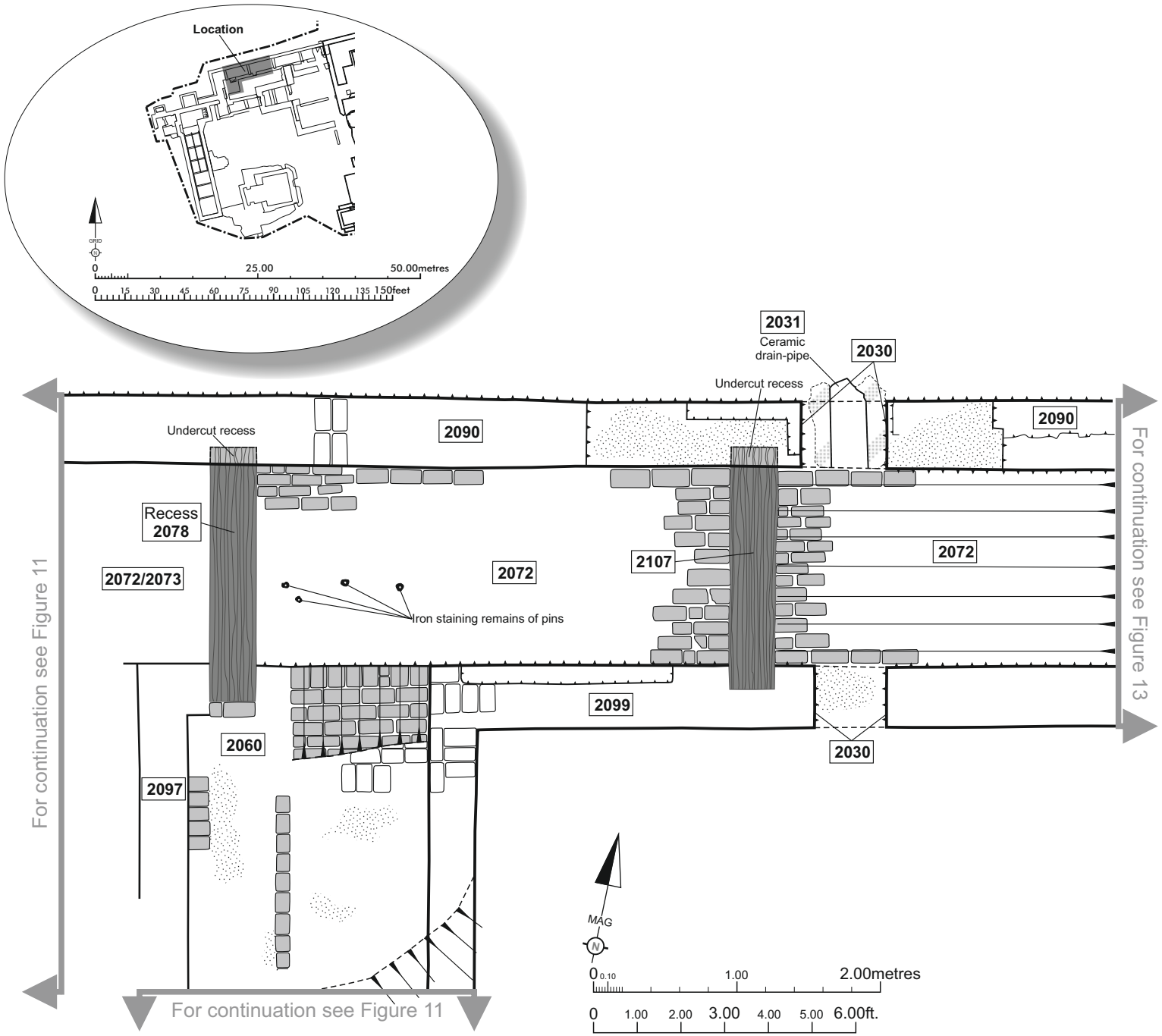


Figure 12. North west section of foundation for distributing screw mechanism.

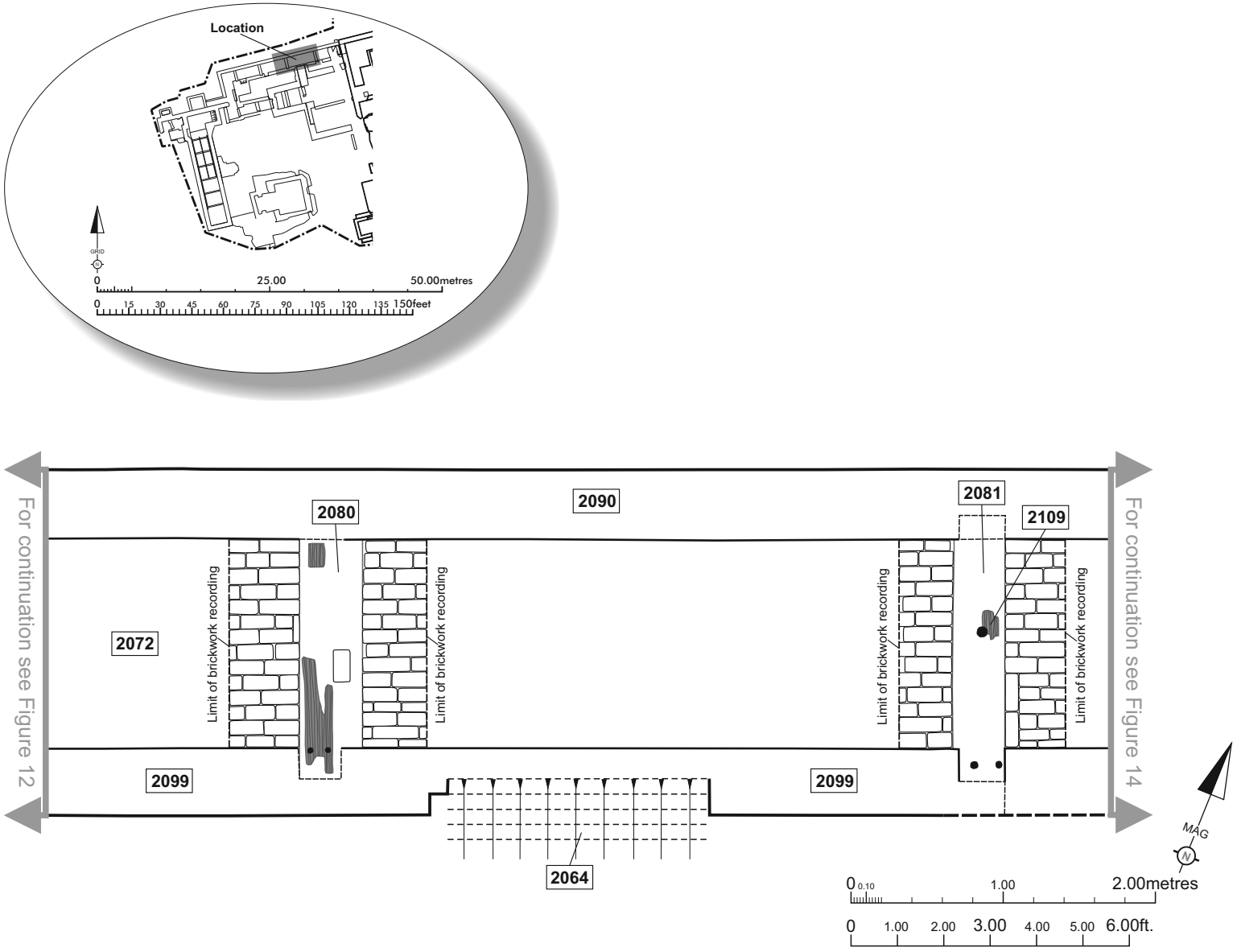


Figure 13. North central section of foundation for distributing screw mechanism.

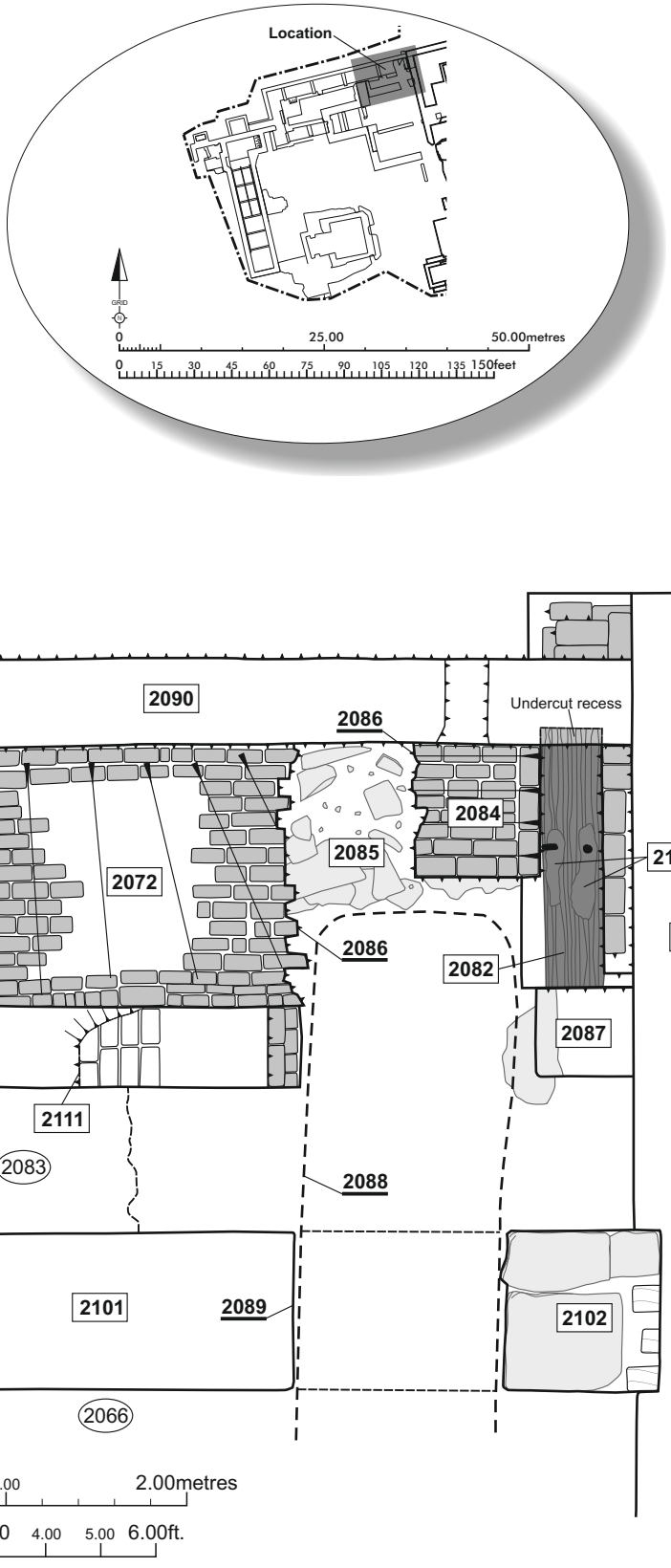


Figure 14. North eastern section of foundation for distributing screw mechanism.

Storage bunkers

The first phase (Phase 3a) bunkers had subsequently been extended northwards by the addition of a new masonry and brick wall (2213) which had been divided internally by two large brick partition walls (2217 and 2218) to create three additional storage bunkers (Plates 60 and 61).

Plate 60. Western elevation of the Phase 3b of the coal storage bunker (wall 2213). Also visible are the brick wall partitions inside the structure to create the bunkers. View to east.

There is a strong possibility that this extension dates to 1894/5 (Phase 3b), as although some Pennant sandstone was used, the key elements were built of the same red brick as used in the Sheppard plant. This suggests that the new arrangements significantly increased production of processed coal, necessitating greater storage capacity.

Plate 61. Phase 3b coal storage bunker. View of the eastern (internal) elevation of wall 2213. Brick partition walls 2217 (left) and 2218 (right) are also visible. Scale divisions are 0.5m.

The space within the new storage bunkers had been excavated during their construction to below what was probably the original natural ground level. The internal walls survived to a minimum height of 2.3m, with the bunkers themselves being filled with demolition material (deposits 2222 and 2223). It was unclear as to whether these bunkers had been filled with crushed coal, as the walls and fill proved to be remarkably free of any form of coal. It is possible that a liner system could have been used to contain this material or, that the bunkers were located at a higher level, in the now lost superstructure; neither the contemporary photograph nor available plan of the washery make the original arrangement clear.

The north east section of the bunker extension (wall 2215) was separated from the western end of the north coke oven battery (wall 2315) by a deposit of coal dust, small pieces of coal and sand (deposit 2313, Plate 62). Tip lines were visible in the deposit suggesting that it had been tipped from the top of wall 2215 *i.e.* from the bunker area and that it was probably deposited to fill the space between the coke ovens and bunker when it was constructed in 1884/5. In addition to simply filling up the space between the buildings, deposit 2313 may also have acted as an insulating layer between the ovens and coal bunker but this is somewhat speculative. The deposit certainly appeared affected by heat and the fine nature of the material in the deposit was not really noted elsewhere. On balance, it is likely that an attempt had been made use deposit 2313 to insulate the coke ovens in this area.

Plate 62. North Coppée oven battery. Insulation deposit 2313 sandwiched between the western end of the north coke oven battery (wall 2315 on the left) and the coal storage bunker (wall 2215 on right). Note the deposit has been heat affected. View to south.

The remains located at the north end of the coal bunkers consisted of a number of substantial, brick and masonry built floors and walls, (floors 2219 to 2221 and walls 2224 to 2226) which formed the remains of the base for the system of dandies which transported processed coal to the top of the coke ovens. The most intact of the floors was 2219, which was a rectangular floor of yellow refractory brick measuring 6m in length by 2.16m. The floor had been damaged during its lifetime, with signs of considerable wear to the upper surface of the bricks and signs of some subsidence (Plate 64) This floor is believed to be associated with trackway for one of the dandies although there was no evidence for the presence of the track itself. The exact nature of the arrangement is unknown but the location corresponds well to the recesses from which the dandies emerge on the 1890s photograph of the Coppée coke plant (Plate 63). The elevation of the floors (204.4m OD) is approximately 1m higher than the upper level of the coke bench water troughs, which are probably the features which are closest to a recognisable ground surface visible on the 1890s photograph. Although it is difficult to assess, the dandies and trackway running along the tops of the coke ovens visible in the photograph would appear to be higher than 1m above the coke bench and it is probable that brick floors 2219 to 2221 represent only the very base of the system.

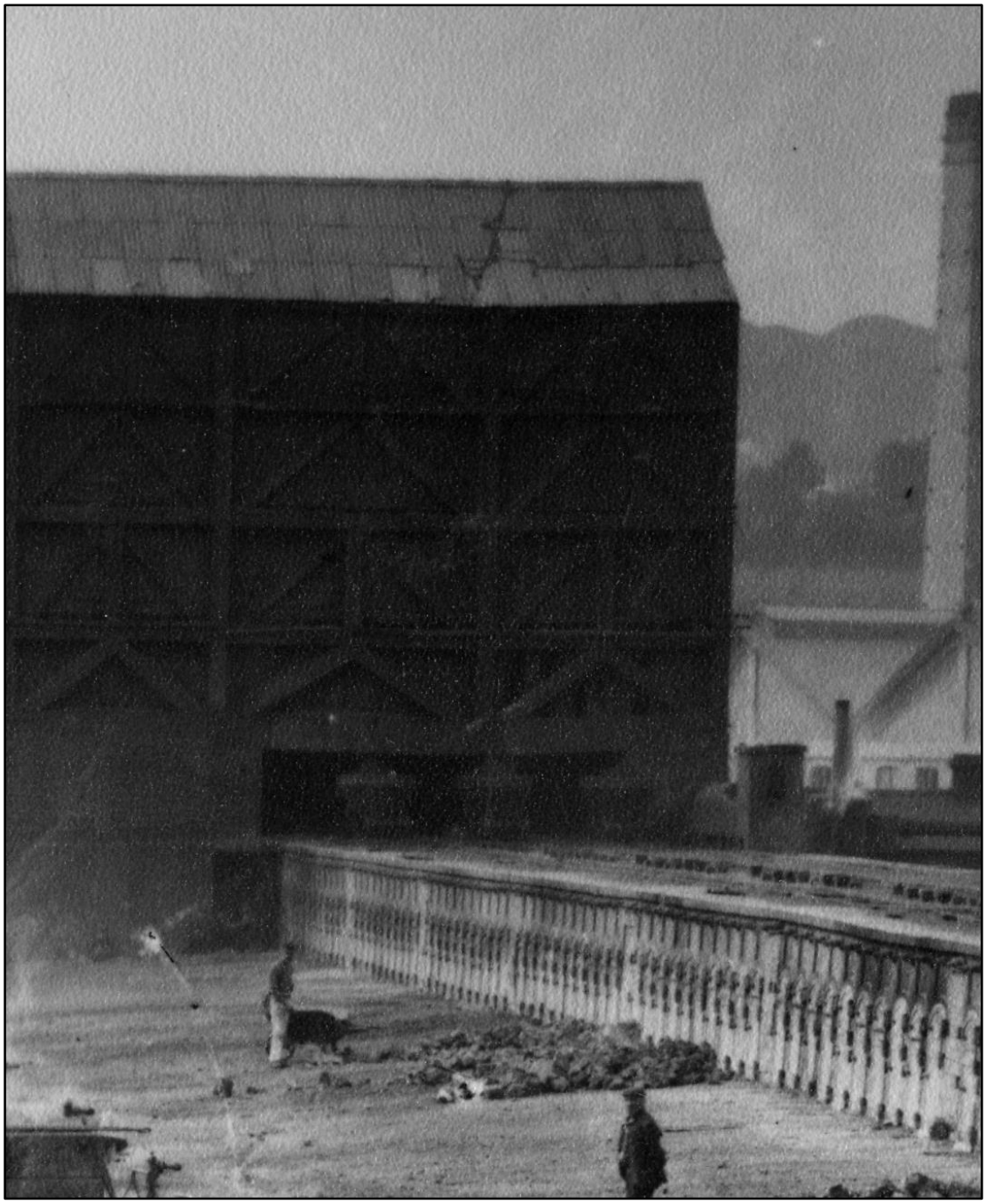


Plate 63. Close-up section of a photograph of the coke works from the 1890s showing three dandies on a trackway along the top of the north coke oven battery. Floor surfaces 2219 to 2221 are believed to relate to the very base of this transportation system, in the location of the recess in the building, which was used to transport processed coal from storage to the tops of the coke ovens. View to north west (Alan George)

Plate 64. North Coppée coke oven battery. Floor surface 2219 looking east to the remains of the coke ovens. This floor is believed to be associated with the transportation system for moving processed coal to the top of the Coppée coke ovens. Note the extensive wear to the surface of the bricks.

Two further brick floor surfaces (2220 and 2221) were located immediately north of 2219 although they were separated from it by a red brick wall (wall 2214). Both of these surfaces

had originally formed a single, rectangular floor measuring 6.9m in length and 3.m in width and made of yellow refractory brick bonded with mid grey mortar. This surface had subsequently been sub-divided by the construction of a masonry stub wall (wall 2229). The function of this division is unknown but the floor itself had been constructed after the neighbouring floor 2219, to which it bore some similarities. Floor 2220, 2221 and wall 2229 had been cut by the trench of a modern pipe (cut 2228), most likely during the period when the site was occupied by the Thorn Lighting works (Plate 65).

Plate 65. North Coppée coke oven battery, floor surface 2221 showing the cut for the modern pipe run (2228). Floor 2221 was almost certainly related to the transportation system for moving coal to the top of the coke ovens but the insertion of the masonry partition (wall 2229 on the right of the photograph) would have significantly affected the space available.

Floors 2219 to 2221 were furnished with substantial brick built retaining walls (walls 2262, 2224 and 2215) which in effect created a box which had been filled with stone, shale and coal debris to provide the foundation upon which the brick floors had been built. These retaining walls survived to a height greater than 2m in places and provided more direct evidence of phasing between the earlier floor 2219 and 2220/2221 although the actual operation of both sets of features is believed to have been contemporaneous. This section of the structure had been partially built over the demolished remains of the Thomas ovens from the Phase 2.

Phase 3a

Coppée coke oven north battery

Details visible on the historic photograph showing both the north and south coke oven batteries show that the ovens were arranged in nine groups of ten, each group being separated by a brick partition (Plate 66). The frontage of each group presented a convex shape so that the whole battery would have had an undulating appearance. The reason for this undulation is unclear but it may have been to reinforce the frontage of the battery. The organisation into groups of ten probably aided operation of the ovens on a rolling cycle; different ovens reached the end of the coking process at different times and it probably made sense to have a group of ten at the same stage rather than have to keep track of individual ovens.

The ovens themselves were fed from what appears to be three, parallel sets of dandies that ran along tracks affixed to the top of the ovens. Each of the long, narrow ovens was fed from all three dandies, as this would allow even loading. It follows therefore that each oven would have had three loading hatches, and some of the possible covers for these were recovered during the excavation (see below).

None of the oven doors were open on the photograph but the doors appear to conform to the double door arrangement described in Proceedings of the North of England Mining and Mechanical Engineering Institute Vol. 22 1872/3 (see Appendix III) *i.e.* consisting of a larger lower door and upper, smaller arched door, both opening on hinges attached to an iron frame. No door furniture appears to have been recovered during the archaeological work which would, if it had, have resolved the question.

Plate 66. Detail from a photograph of the north coke oven battery in the 1890s (Alan George)

Nothing of the superstructure of the coke ovens discussed above survived. The North battery of coke ovens proved to have survived in a better condition than the south, probably due to the fact that the Thorn Lighting works destroyed the southern battery almost totally. Nevertheless,

the north battery survived in a very poor state, with essentially only the foundations remaining (Plate 67). The surviving portion of the north battery measured 45.6m in length x 12m in width, with elements surviving to a height above the excavated level of 1.1m (202m OD).

Plate 67. Remains of the strip foundations of the north battery of Coppée coke ovens. View to east. Wall 2314 is visible to the right of the photograph whilst wall 2324 is visible on the left. The space between is filled with a series of linear brick foundations, and the base of a single, large flue (2340 and 2343) is located adjacent to the left hand wall. View to north east.

No significant structural elements were noted during removal of the overburden above the surviving foundations which comprised four separate elements; retaining wall 2314, a series of brick built strip foundations (structures 2328 to 2331), the remains of a main heat flue (chimney 2338, pillar 2339, floor 2340, floor 2434 and walls 2435 and 2436) and a series of brick bays serving as heat channels (group 2468). Each of these surviving elements is discussed below.

North coke oven strip foundations 2328 to 2331

These foundations consisted of four east/west oriented linear strips of red and yellow refractory brick bonded with a white, powdery lime based mortar. Each had a uniform width of 0.7m but the excavated lengths varied from 32.6m to 34.6m. This variation in length is not believed to be significant but is a result of differential survival of the features. Each of the foundations had a depth of 0.09m, consisting as they did of a single course of brick and probably representing the very base of the foundation. The bricks in each of the foundations were constructed the

same way, with a double row of brick laid face down flanked on either side by a row of brick laid edge-on (Plate 68). Each of the foundations was separated from its neighbour by a gap of 0.8m which had been filled with fine grained demolition material which had been clearly heat affected. This material is likely to have been deposited on initial construction of the ovens as it was too fine to have been the result of post-demolition deposition.

Plate 68. North coke oven battery, strip foundations 2328 (left) to 2331 (right). Retaining wall 2341 is on the far left of the image whilst the remains of the main heat flue are on the far right.

Two of the foundations (2330 and 2331) were connected by a separate strip of brickwork but the function of this connection is unknown. These foundations are believed to have provided transverse structural support for the coke ovens that would have been situated above (see drawing at Appendix III). Not enough of the foundation survived to state whether or not the gaps between the foundations were originally hollow but there is some evidence from contemporary drawings of other Coppée ovens to suggest that each battery was equipped with an extensive network of flues to allow heat to be evenly distributed, and this may well have been the case at Cyfarthfa. The strip foundations are therefore likely to be the remains of the bottom-most set of cooling flues for regulating the heat within the overlying ovens.

North coke oven battery retaining wall 2314

The remains of this east/west oriented wall survived to a length of 41m, a maximum height of 1.1m and a width of 1.45m at the base. The wall had been constructed of yellow refractory bricks laid in English Bond and bonded with light grey lime based mortar. The southern elevation presented a vertical face whilst the north elevation had a stepped appearance where bricks had been removed or fallen off (Plate 69).

Plate 69. North Coppée coke oven battery, retaining wall 2314 looking along its length. View to west. The vertical left hand face of the wall is likely to mark the location of the front of the Coppée ovens.

The retaining wall is likely to have acted as the substantial foundation for the front of the coke ovens, although no structural evidence for this survived.

North coke oven main gas flue

Elements of the main gas flue for the north Coppée coke oven battery survived in the form of a number of features, specifically flue base 2338, pillar 2339, floor 2340, floor 2434 and walls 2435 and 2436. The structure was built entirely of yellow refractory brick, some of which was specialist in nature in order for it to fulfil certain functions, such as forming arches. The flue was oriented east to west, parallel with the foundations for the ovens.

The base of the main gas flue consisted of a brick surface (2340, Plate 70), 8.64m long and 2.06m wide. The base of the flue had an elevation of 202.44m OD which placed it 1.3m below the level of the northern coke bench trough, which is probably close to the original working surface for the bench. Although circumstantial, in the absence of surviving features, this suggests that the main gas flue for the north oven battery was not buried particularly deeply when it was operational, a fact that may have permitted easier access for the purpose of inspection and repair.

Plate 70. Northern Coppée coke oven battery, surviving floor (2340) of the main gas flue. Note the highly vitrified original floor of the flue just above the ranging rod. View to east.

The bricks in floor 2340 had been laid in at least seven courses, each laid in a particular way to create a concave surface which would have formed part of the circular section of the main gas flue. All the bricks in the floor appeared to be of conventional design, bonded with a very

light grey/white lime based mortar. Although the majority of the flue's length was damaged, two original sections of the inside of the flue did survive; these were highly vitrified, indicating the great heat of the gasses carried by the flue. The roof of the main gas flue had been supported by brick pillars, the bases of two surviving in the vitrified floor section (Plate 71). Each of these pillars measured 0.3m by 0.3m and were set 3.2m apart.

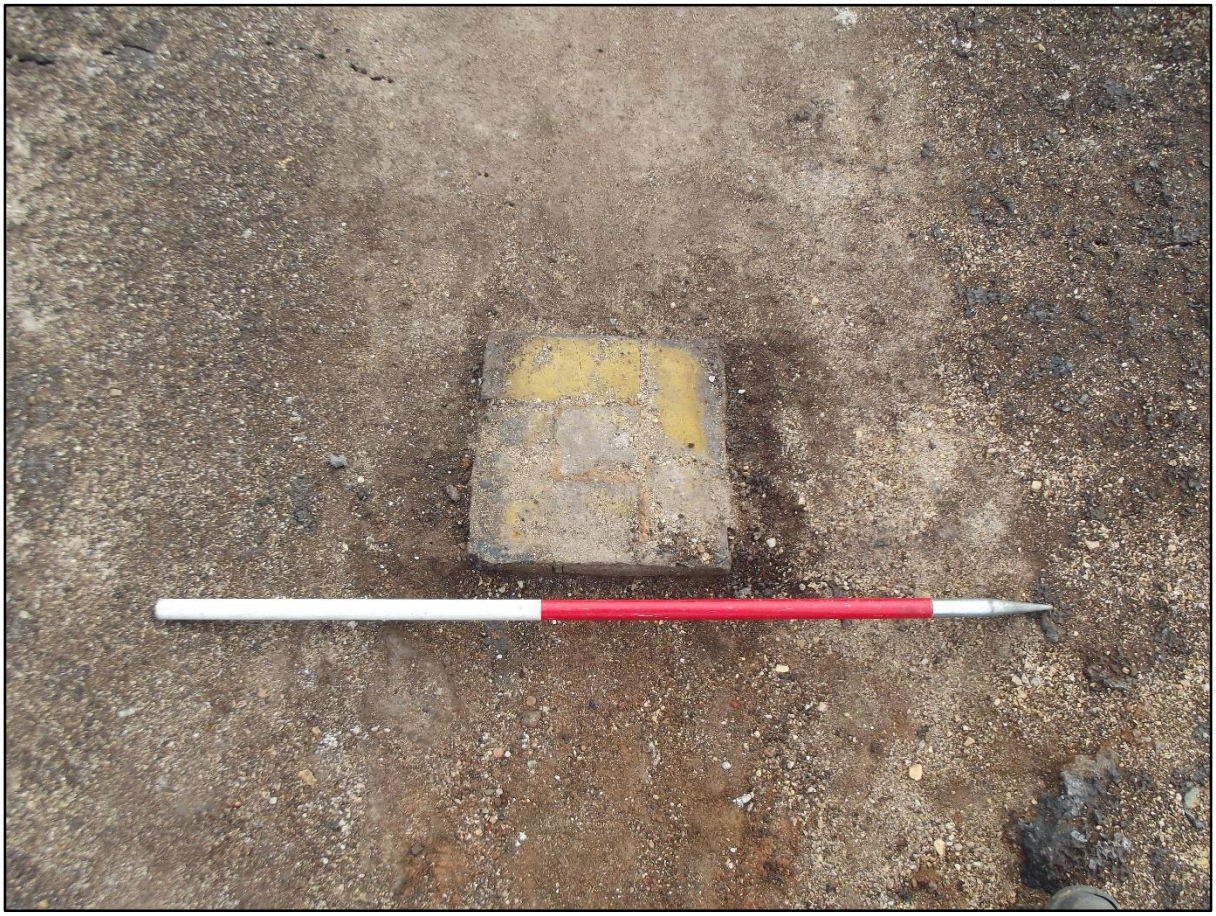


Plate 71. North Coppée coke oven battery, one of the two surviving pillar bases in the vitrified surface of the main gas flue. Scale divisions are 0.5m

The eastern end of floor 2340 terminated in a semi-circular chamber (2338), broadly square in plan and measuring 2.03m by 1.83 and having a maximum a depth of 1.8m. This feature was originally interpreted as a potential chimney but proved to be the opening of a secondary gas flue, running at 90 degrees to the north from the direction of the main gas flue. The southern elevation of the chamber consisted of a brick wall (Plate 72) but the northern elevation consisted of the mouth of an arched flue supported by a brick pillar. The whole of the chamber, but particularly the area around the mouth of the secondary gas flue, was highly vitrified (Figure 15, Plate 74).

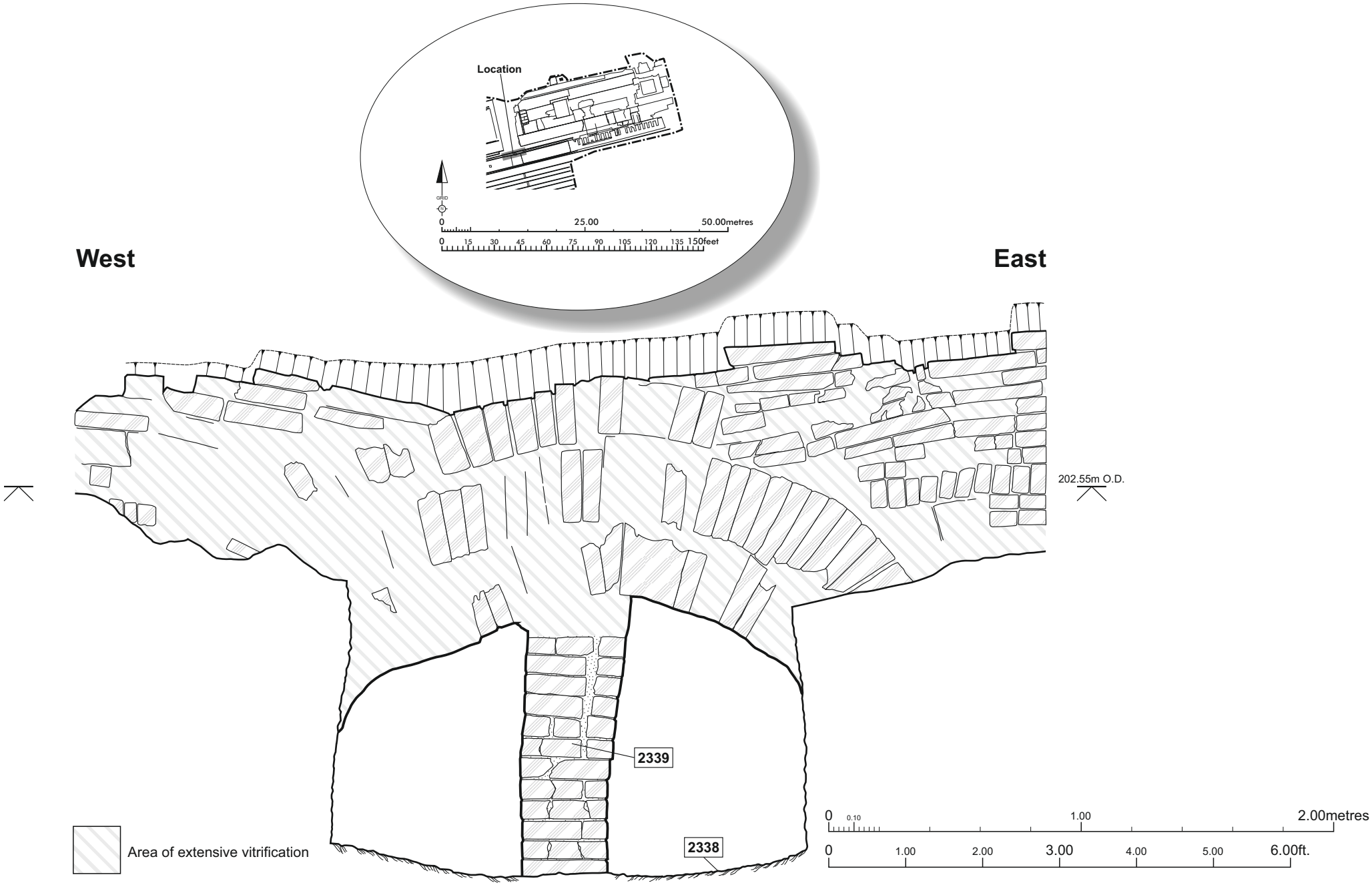


Figure 15. Vitrified mouth of main gas flue down-take, northern coke oven battery.

Plate 72. North Coppée oven battery, South wall of secondary gas flue 2338, view to south.

Not only was the floor of chamber 2338 semi-circular, but it also sloped down to the north, towards the mouth of the gas flue. This was a particularly skilled demonstration of bricklaying, with the resulting shape of the chamber being semi conical (Plates 72 and 73). This feature goes some way to justify the statement that Coppée ovens were expensive to build owing to the highly skilled nature of their construction (*Proceedings of the North of England Mining and Mechanical Engineering Institute Vol. 22 1872/3*).

Plate 73. North Coppée oven battery, secondary gas flue chamber 2338. The floor of this chamber sloped in two dimensions, demonstrating the highly skilled nature of the workmanship involved. Note the extensive vitrification. View to east.

The secondary gas flue itself measured 1.2m in height by 1.88m wide and was highly distorted in shape by the effects of heat. The supporting brick built pillar (3339) had been slightly off-set from the centre of the flue mouth, (Plate 74) although whether this was as a result of partial collapse due heat damage was unclear. What was also unclear was whether the pillar had been constructed as part of initial construction or whether it had been inserted to support the clearly sagging flue mouth, although this is the most likely scenario. The interior of the secondary flue was partially filled with demolition material but the interior of the flue was visible being covered in a thick deposit of vitrified material that is likely to be residue deposited by the passage of the gasses through the channel.

Plate 74. North Coppée oven battery, mouth of the secondary gas flue running from the main gas flue. Note the collapsing arch and the attempt at support being provided by brick pillar 2339. View to north.

Of particular note were the patterns of deposition of this residue on the brickwork. These had a distinctive 'feathery' appearance and contained thousands of flow lines that suggested the direction in which the gas moved (Plates 75 and 76). These flow lines confirmed that the gasses had travelled from the main flue into the secondary gas flue, although the final destination is unclear as the secondary flue was damaged and open to the air beyond 5m.

Plate 75. North Coppée oven battery, flow lines in the residue within secondary gas flue 2338. Scale is 0.5m

Plate 76. North Coppée coke oven battery, characteristic flow lines in the residue left on the side walls of the secondary gas flue. Scale is 0.5m.

A second section of the main gas flue was located to the east of secondary flue chamber 2338, continuing the line of the flue. This section was the best preserved area of the main gas flue as elements of both the side walls of the flue itself had survived (walls 2435 and 2436). The floor (2434) measured 8.64m in length and had a width of 2.05m, exhibiting the same concave appearance as floor 2340; the brickwork was vitrified but no bases for supporting pillars were noted. However, floor 2434 did slope upwards from west to east, rising 0.4m over the course of its 8.2m length.

The north wall of the flue (2035) was built of yellow refractory brick, bonded with light grey/white lime mortar (Plate 77). It survived to a length of 9.4m, a maximum height of 0.8m and a width of 0.3m. Behind the fair face of the flue wall, the majority of the material consisted of rubble fill (2394) and this filled the space between the flue and the adjacent structure, masonry wall 2437.

Plate 77. North Coppée coke oven battery, the north wall of the main gas flue (wall 2435). View to north with masonry wall 2437 to the rear.

The southern flue wall, (wall 2436) survived to a length of 9.4m, maximum width of 0.3m and a maximum height of 0.74m. The wall had been built as a vertical structure for five brick coursed before a springing point had been introduced at a height from the flue floor of 0.35m. Two courses of the arch had survived in places, which was constructed of specialist yellow refractory brick, which was wedge shaped in section and square in plan. These bricks were

stamped “King Brothers Stourbridge” and for a fuller discussion, the reader is referred to the brick report section.

The external face of the southern flue wall appeared to have been reinforced in the region of the secondary flue chamber by a second skin of brick (2508), 3m long, which comprised up to eight courses of heavily vitrified purple/brown coloured standard bricks bonded with yellow/brown lime mortar (Plate 78). However, it is possible that this much damaged feature was the only surviving portion of the long flues that ran transversely to the direction of the ovens, for which only the foundations survived (foundations 2328 to 2331). A contemporary description of the construction of the ovens suggest that the brick used in these flues was not of refractory type (*Proceedings of the North of England Mining and Mechanical Engineering Institute Vol. 22 1872/3*) and this seems to be the case for feature 2508. The interior of both surviving walls showed evidence of vitrification due to heat.

Plate 78. North Coppée coke oven battery, the south wall of the main gas flue (wall 2436) to the rear, and feature 2508, with a ranging rod resting on it. feature 2508 may, in fact have been the only surviving portion of the walls of the transverse flues for the ovens. View to north.

North battery boiler flue system

The north east corner of the site proved to contain some of the best preserved elements of the coke works in the form of a complicated system of flues to channel gas from the ovens to a set

of boilers in order to generate steam to power different elements of the works. The flues were arranged with a long axis west to east, continuing the line of the coke rammer walls (see below). Very little of the area formerly occupied by the boilers was seen as it lay to the north, outside the development area. However, significant elements of the system of down-takes for the gas were present, together with the substantial masonry and brick structures necessary to house them. Several areas containing traces of asbestos were noted during the work in this area, although these were all to the north of the main recorded structures, at the very periphery of the excavated area. The presence of this material unfortunately hindered wider exploration of this area.

The system overall appeared to have been somewhat organic in nature, showing evidence of repairs and alteration over its lifetime, possibly necessitated by heat damage. Essentially the remains of the system consisted of one or two chimney bases linked by an east/west oriented main flue (flue 2448). This main flue was supported on either side by substantial masonry walls (north wall 2443 and south wall 2437), forming a 'cradle' for the construction of the flues, and possibly serving as an extension of the coke rammer wall. The main flue was exposed for a distance of 26.5m but the eastern end remained buried as it lay outside the excavated area. Three secondary flues (2442, 2448 and 2453) were situated in the south wall of the main flue although an additional secondary flue was located which had been blocked. There were no similar features flues in the north wall of the main flue but a single flue linked the base of one of the chimneys (chimney 2464) to the boiler complex that originally lay to the north.

The north masonry wall of the flue complex (wall 2442) had an average width of 2m and had a length of 20.2m; a short continuation of the north wall extended to the east (wall 2465) but was only exposed for a length of 1.3m before running outside the development area. These two sections of the north wall were separated by a brick flue (flue 2459) and associated supporting structures (floors 2460 and 2461). The north elevation of wall 2442 survived to an average height of 2.5m although the original fair facing of the wall had been robbed out, with only the lowest two courses surviving intact. The wall had been constructed with a rubble core and faced with un-coursed stone blocks, bonded with mid-grey coloured lime mortar. The best preserved section of the wall was the southern elevation, which not only retained the facing stones but contained a step where the wall became narrower (Plate 79).

Plate 79. North Coppée coke oven flue complex, south elevation of wall 2442 showing stepped foundation. View to north.

The surviving elements of the south masonry wall of the flue complex (wall 2437) measured 11.3m in length, 1.92m in width and had a height, as exposed, ranging between 1.76m on the outside, southern elevation and 0.84m on the inner, north elevation. The wall was constructed of un-coursed stone blocks bonded with mid-grey lime mortar. This wall differed from the north one in that it incorporated a number of flues, some of which were later insertions, and the wall itself was separated from the main gas flue to the south by a deposit of rubble, (rubble 2394) which appeared to act as a filling deposit between the two structures; neither did the wall have a step where the foundation narrowed (Plate 80).

Plate 80. North Coppée oven flue complex, north elevation of wall 2437. Note the absence of a stepped foundation. Brick floor 2481 is visible, as is part of a chamber forming part of chimney 2464. View to south.

The inner (northern) elevation of wall 2437 included yellow refractory brick inserts replacing the masonry to accommodate the flues, and the inner face of the wall was heat affected in these areas, being red in colour.

Both the north and south walls were furnished with abutting brick floor surfaces on their inner elevations. That for the north wall (brick floor 2446) was a broadly rectangular, continuous surface, 21m long with a maximum width of 1.84m, made of a variety of brick bonded with dark grey lime mortar (Plate 81). The westernmost 9m of the surface was one course of brick lower than that located further east but the purpose of this step is unclear. The depth of the surface was not established but it probably exceeded 2m as the floor acted as one half of a channel that contained the main gas flue and chimney bases in this area.

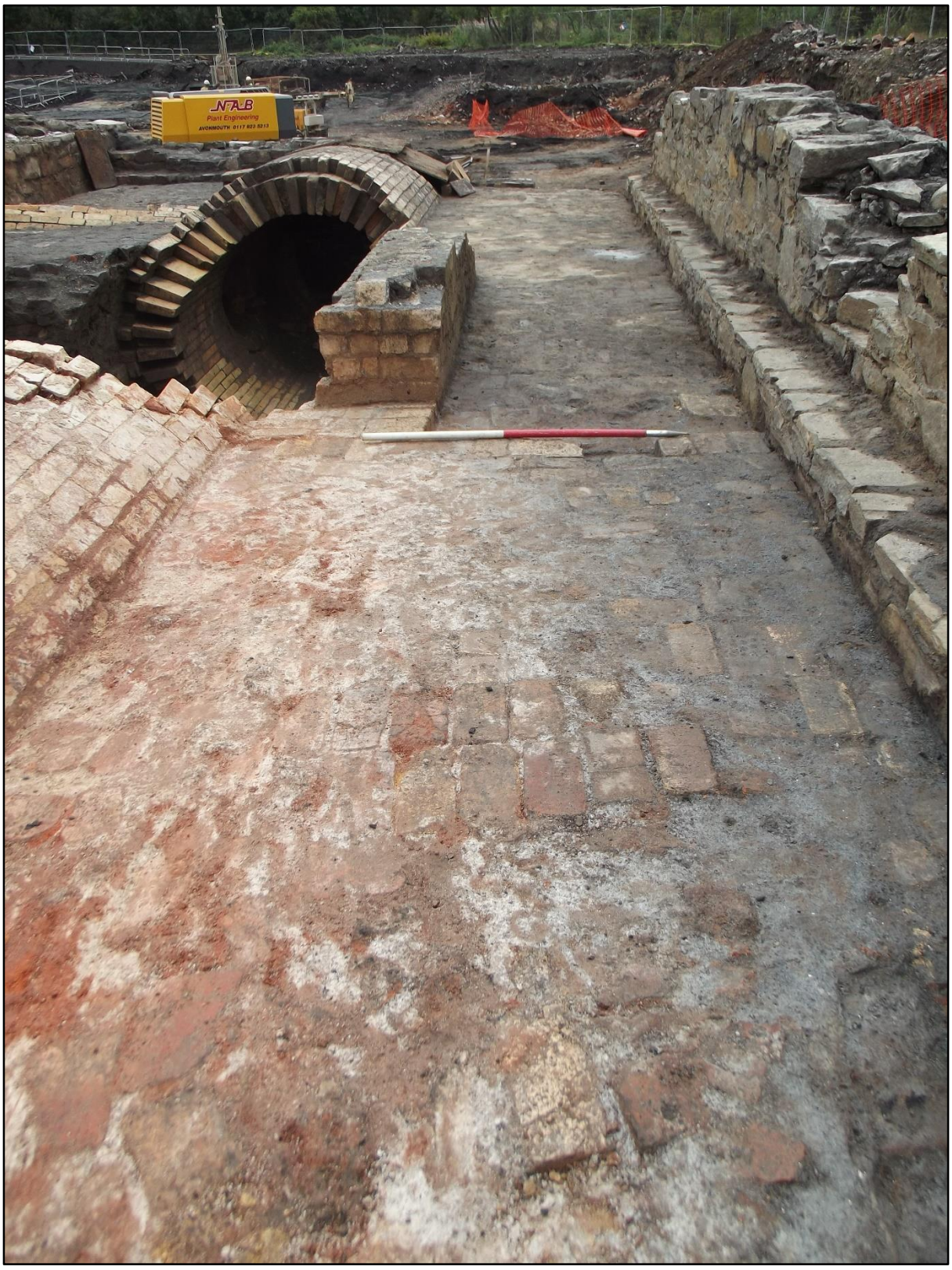


Plate 81. North Coppée coke oven flue complex, view of floor surface 2446 that formed the north side of the channel for the main gas flue in this area. Note the gas flue to the right and wall 2443 to the right. View to west.

The southern floor surface was interrupted by secondary flues, which had caused the excavation team to issue several context numbers for what was essentially the same feature

(floors 2438, 2439, 2440 and 2482). Overall the floor was very similar in nature to floor 2446, being constructed from a variety of brick bonded with dark grey lime mortar although much of the surface was covered in a mid-grey mortar render. The floor had a combined length of 27.7m and an average width of 2.1m; the depth again probably exceeded 2m as the combined floors formed the southern half of the channel containing the main gas flue (Plate 82).

Plate 82. North Coppée coke oven flue complex, showing the arrangement of walls and floors to create a substantial 'cradle' in which to construct main gas flue 2448. Junction base 2464 is closest to the camera. View to west.

The main flue itself, (flue 2448) had been constructed of yellow refractory brick to form a circular feature with an internal diameter of 1.55m and an external diameter of 2.3m. The surviving elements consisted of three separate sections (flue sections 2441, 2448 and 2456) but followed the same method of construction. The outer skin of the flue had been constructed

from a combination of standard and half sized yellow refractory brick, some of which had been laid edge-on (Plate 83).

Plate 83. North Coppée oven gas flues, roof of the main gas flue 2448 showing the outer skin of standard refractory brick and the outer surface of the specialist wedge shaped brick that formed the flue itself. Scale is 2m. View to south.

The inner skin of the flue had been constructed of specialist wedge shaped refractory brick fitted together with very fine tolerances and bonded with a thin layer of yellow/brown mortar. Loose examples of these voussoir bricks were noted as having been stamped with a capital 'H' (see brick report). The inner skin of the flue was of particularly skilled workmanship, resulting in an almost perfectly circular section within the flue (Plate 84). The interstices between the circular flue and the channel in which it had been built had been filled with refractory brick laid to accommodate the shape of the complex shape involved. No rubble coring had apparently been used, possibly because the potential temperatures involved required the best quality materials and workmanship. Within the course of the channel, the basic shape of the flue had been formed from a number of courses of standard yellow refractory brick. The standard brick outer skin of the flue extended all the way around and the lower half of the circular flue had then been formed from wedge shaped specialist yellow refractory bricks whilst the upper half had been constructed by similar shaped bricks but which were longer and narrower (see Plate 84).

Plate 84. North Coppée Coke oven flue complex, oblique sectional view through damaged main gas flue 2441. Note the method of construction using high quality specialist bricks. Scale is 1m, View to west.

The western end of the flue abutted a masonry wall (walls 2433 and 2471) which formed the eastern section of the main Coppée oven down-take channel (Plates 85 and 86). Whilst the lower half of the flue abutted the wall, the roof had never been completed, instead being capped by four rectangular iron plates (plates 2444), one of which had broken into two pieces. These were *in situ* at the time of the excavation and appeared to serve as a removable inspection cover that provided access to the main gas flue. Each of the 5mm thick sheets measured 1.21m by 1.61m and were aligned with the long edges running parallel to the direction of the flue (Plates 87 and 88). Several spare specialist refractory bricks had been used to prop the plates up so they did not move but otherwise the arrangement was unremarkable. The discovery of the plates does however suggest that a minimal amount of heat was encountered in this section of the flue, a fact supported by the fact that the interior of the flue displayed no evidence of vitrification or discolouration caused by heat.

Plate 85. North Coppée coke oven flue complex, view of the interior of the western end of main gas flue 2448 showing the lower half of the flue abutting wall 2433. View to west.

Plate 86. North Coppée coke oven gas flue complex, view of the unfinished western terminal of flue 2448. View to north west.

Plate 87. North Coppée coke oven flue complex, iron plates 2444 placed over the uncompleted western terminal of main gas flue 2448 as a removable inspection cover. Note the specialist bricks propping the sheets in place, which were found in their original positions. View to south.

Plate 88. North Coppée coke oven flue complex, oblique view of the western terminal of main gas flue 2448. Several interesting features are visible including the mouth of secondary flue 2442 inside the main flue, and iron plates 2444. View to south west.

A central section of the main gas flue had been filled with demolition debris and was left unexcavated. However, the roof of this section was notable as it showed clear signs of damage and modification having occurred during its lifetime. In particular, a brick insert or repair had been made to coincide with the position of a secondary, north/south oriented flue in the south wall (flue 2447 and brick insert 2470); this insert was made of a lighter coloured standard refractory brick bonded with yellow/brown coloured mortar. The roof of the main flue obviously sagged in this area although it is unclear as to whether the repair was intended to correct this or was a subsequent feature of the repair (Plate 89).

Plate 89. North Coppée coke oven flue complex, repair or insert to the roof of the main gas flue 2448. The repair may have been intended to remedy a collapse of secondary flue 2447, which is visible at the bottom of the image. View to north.

A second north/south oriented flue was located 6.4m to the east of the junction of flues 2448 and 2447 although no repairs had been affected at this junction. This second flue (flue 2453) was also oriented north/south and had been built into the south wall of the flue complex. Both these secondary flues are discussed below.

The main gas flue was interrupted in two places, where square chambers had been constructed (bases 2132 and 2464). It was initially thought these were chimney bases but they are more likely to be 'junction boxes'.

Base 2132 was located 6.3m from the western terminal of the main gas flue and consisted of a sub-square chamber measuring 2.3m by 2.9m, constructed from standard yellow refractory brick. The brick was of the standard yellow refractory type laid in alternate header and stretcher bond and cemented with coal rich lime mortar; the floor of the chamber was also of brick construction. A brick surround (wall 2445), 2.27m in height had been constructed into the north edge of the chamber and formed the north wall of the chimney base (Plate 90). The southern wall was rather less well made, being formed of the side of floor 2439, with no specific insert. Both the west and east ends of the chamber were open, to accommodate the line of the main gas flue, the ends of which projected slightly into the chamber.

Plate 90. North Coppée coke oven complex, north wall of chimney base 2132. The structures just visible to left and right are the mouths of main gas flue 2448. View to north.

Both projecting ends of the main gas flue were well constructed of yellow refractory brick and although both were damaged, they provided an insight into how the flue itself had been constructed (Plates 91 and 92).

Plate 91. North Coppée coke oven flue complex, mouth of main gas flue 2448 at its junction with chimney base 2132. Floor surface 2439 also served as the south wall of the chamber. View to east.

Whereas the western mouth of the main gas flue had been open, the eastern mouth had been partially blocked by the construction of a brick wall covering the lower half of the channel (Plate 92, Figure 16). It is possible that this wall acted as a baffle in order to reduce the amount of residue within chimney base 2132, as a considerable build-up of apparently heat affected material had built up behind it, on the inside of the flue. A circular ceramic pipe had been built into the wall but its function is unclear. The roof of the flue in this location appeared heat affected, with some distortion of the shape of the flue having occurred. There was no evidence of heat damage or modification for heat management to the opposite, western flue mouth, although this section was more extensively damaged.

The centre line of the chimney base was off-set to the south from the line of the main gas flue (see Plate 92), which was probably to facilitate construction of the flue rather than any other reason.

Plate 92. North Coppée coke oven flue complex, partially blocked mouth of the main gas flue within chimney base 2132. This feature was possibly a baffle to reduce the ingress of residue into the chamber base. Note the distortion of the roof, probably caused by heat. View to east.

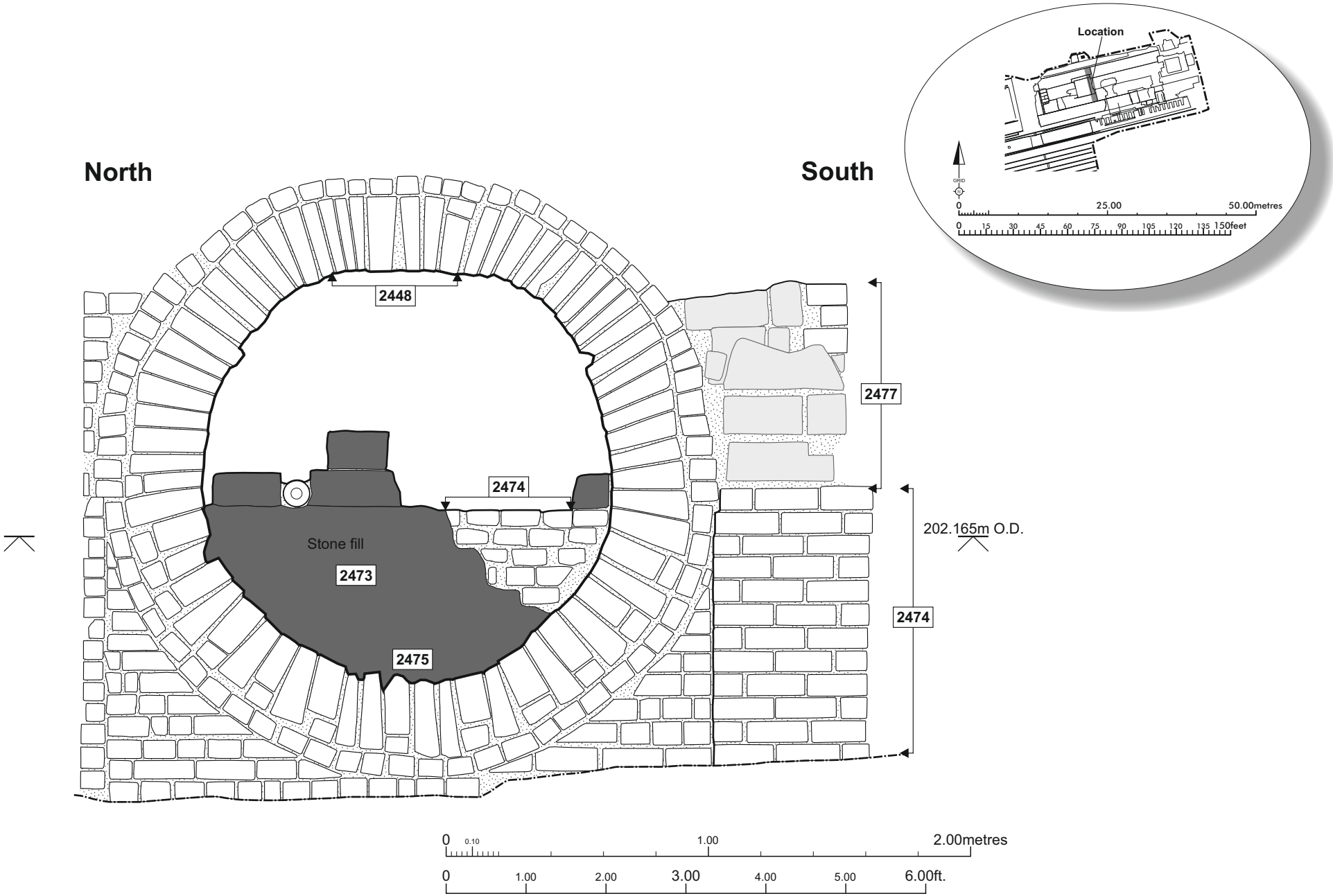


Figure 16. Baffle arrangement partially blocking the western chimney base.

The eastern chamber (2464) consisted of a rectangular box measuring 2.45m by 2.57m constructed largely of yellow refractory brick. This base served as the junction of three large flues (flues 2456, 2448 and 2459) and was quite unlike chimney base 2132, which was located 13.2m to the west. The base was also dissimilar in that the upper levels incorporated the spring points of multiple arched roofs, leading to the conclusion that base 2464 was simply a heavily reinforced junction point, and not a chimney. The bricks used to construct the feature were of a specialist refractory type, some of which were stamped 'J.B. Fisher and Company' (see brick report). The mouths of each of the flues that opened into the chamber had been provided with brick reinforcing collars (Plate 93).

Plate 93. North Coppée coke oven flue complex, brick chamber 2464, which was the junction of flues 2456, 2448 and 2459. Scale is 2m, View to north.

One other factor militating against chamber 2464 being a chimney base was the fact that the upper elements of the north and south walls of the chamber were furnished with obvious spring points for the continuation of arches, which would not be the case were the chamber to be a chimney base.

The actual depth of the chamber was never ascertained as it had been filled with a deposit of mixed stone, brick and heat affected residue (deposit 2463) which was not fully excavated due to constraints of time. The arched collars on the western flue (flue 2458) and eastern flue (flue 2456) had buckled. It is unclear as to whether this was caused during the lifetime of the works but is likely to be post-decommissioning damage.

The western flue mouth and collar had an exposed width of 2.05m and height of 1.26m, the structure had been constructed from a double skin of specialist brick (Plate 94). The eastern flue mouth (flue 2456) was of identical construction, having an exposed height of 1.3m and a width of 1.06m. The flue was described as elliptical in shape but a large crack was visible in the brickwork and the flue had consequently distorted into an ellipse (Plate 95).

Plate 94. North Coppée coke oven flue complex, mouth of the western flue (flue 2458) opening into flue junction 2464. View to west.

Plate 95. North Coppée coke oven flue complex, eastern flued mouth 2456 opening into flue junction 2464. View to east.

The mouth of the north flue (flue 2459) that opened into junction chamber 2464 was of similar construction but set lower down in the chamber. Substantially more of the flue was visible outside the chamber than inside, with a length of 2.7m and width of 1.92m being exposed. The flue itself dipped down to the north after it left the chamber, towards the location of the boiler complex indicated on historic mapping.

Unfortunately, this area was outside the development area and the overall length of the flue was not established. The roof of the flue was constructed of standard refractory brick bonded with light grey lime mortar, in a similar fashion to the others noted in the complex. Although damaged, the constructional details of the point at which flue 2459 entered the flue junction were clearly visible, again providing ample evidence of the high quality of the bricklaying (Plate 96). The exposed section demonstrated that a relieving arch had also been constructed above the flue and demonstrating it to be a twin of the down-take from the main coke oven gas flue.

Plate 96. North Coppée coke oven flue complex, rear view of flue 2459 showing the reinforced collar of the flue and elements of the relieving arch on either side. View to south.

Four secondary flues were or had been located in the south wall of the flue complex. Of these four, two provided a connection between main gas flue 2448 and brick chamber group 2468, located to the south. One appeared to have done so originally but had been truncated by the construction of masonry wall 2437, and one was only visible as a blocked archway in the south elevation of wall 2437 (Plates 98 to 99). These secondary flues were of similar construction, consisting of circular brick channels, angled downwards to the north, and having reinforcing collars close to the south wall. Only one of these flues could be seen from within the main gas flue, this being flue 2442 (Plate 97). However, the southern end of 2442 had been truncated by the construction of wall 2437, which indicated that extensive re-modelling had taken place.

Plate 97. North Coppée coke oven flue complex, mouth of flue 2442 entering main gas flue 2441. View to south west.

The mouths of the remaining flues were either buried in unexcavated sections (flues 2447 and 2453) of the main gas flue or had no apparent channel (blocked archway 2449) at the time of the decommissioning of the plant.

Plate 98. North Coppée coke oven flue complex, rear of blocked archway 2449. This may be a vestigial flue that once connected the main gas flue with brick base group 2468. View to north.

Plate 99. North Coppée coke oven flue complex, Blocked archway 2449. Note brick base group 2468 to the rear of the arch. View to south.

Brick bay group 2468

The main gas flue for the north coke oven battery terminated at the east end in a vertical wall, which isolated it from a grouping of rectangular brick built bays (Group 2468). This group was a 15.1m long and 1.78m wide area of multiple (at least 16) brick built bays (Figure 17, Plates 101 to 104). The group was almost certainly longer originally but the eastern end remained buried as it ran outside the development area. The whole structure was made mostly of standard sized, yellow refractory brick bonded with brown/yellow mortar, although a number of specialist bricks were present in the bays. Specifically, these examples were related to capping of the only fully intact bay in the group, with the uppermost bricks of the dividing walls being chamfered to accept capping bricks (Plate 100).

Plate 100. North Coppée oven battery, a capping brick in place over one of the brick bays forming part of group 2468. Note the chamfered nature of the brick to ensure a good seal. Scale is 0.5m

Each of the rectangular bays measured 1.03m in length, 0.3m wide had an average of 0.42m in depth, being open ended to the north, where a 0.21m wide channel had been constructed running the entire length of the bay openings (brick channel 2480). Both the sides of the channel and the interior of the bays were partially vitrified and discoloured red by the effects of heat, although there was none of the residual deposition visible as noted within the main gas flue. The construction of the group was something of an enigma; it had certainly been built within a continuation of the main gas flue, effectively blocking the flue at its eastern end. No evidence survived to suggest that both the main gas flue and bay group 2468 had been

connected although the possibility cannot be discounted; the absence of residue does however suggest that there was no connection. There was some evidence, in the form of vitrification on the side walls of the main gas flue, that the group of bays had been inserted after the main gas flue had been in use.

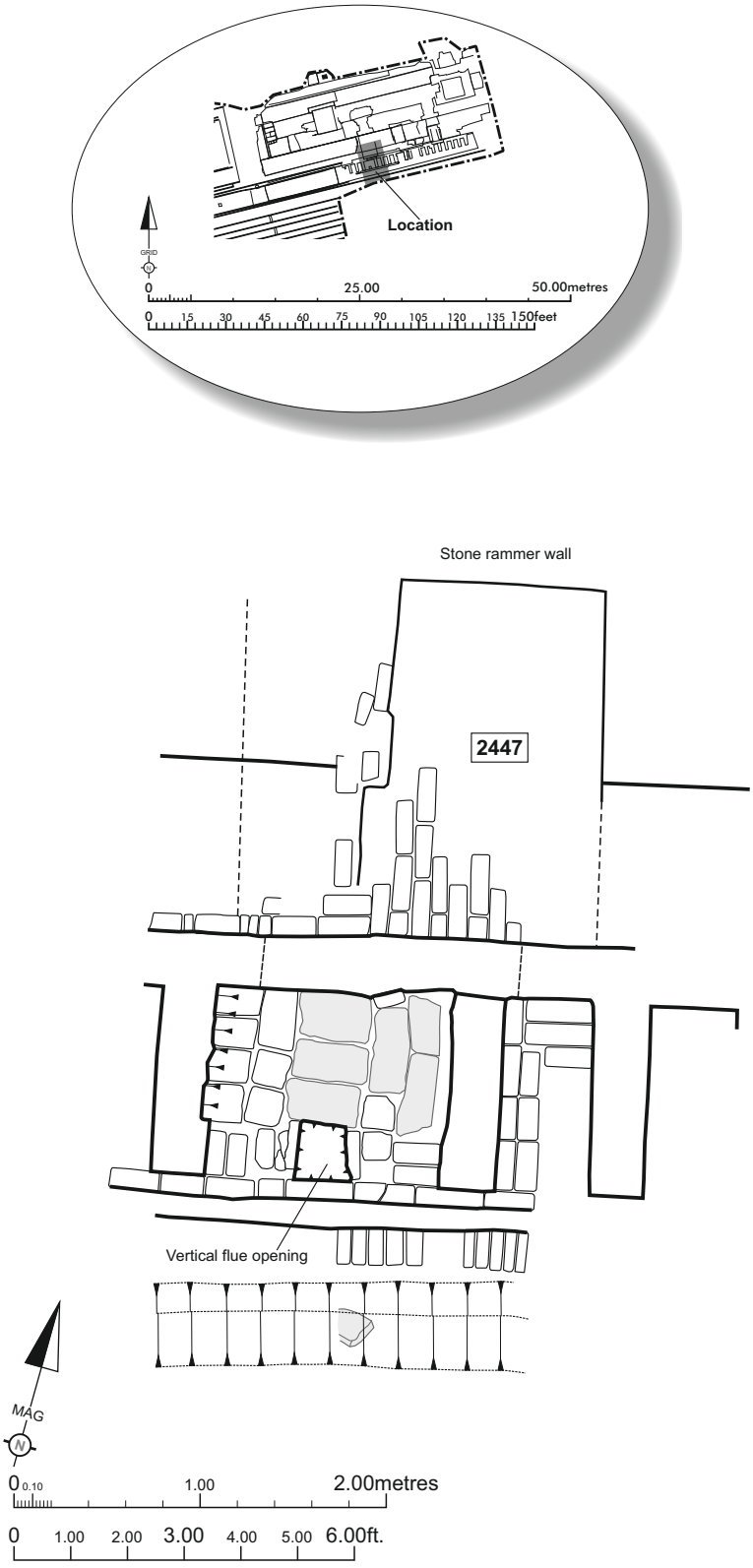


Figure 17. Plan of an area of brick bay group 2468.

Plate 101. North Coppée coke oven battery, brick built bays group 2468 looking south east

Plate 102. North Coppée coke oven battery, brick bay group 2468, view to east

Plate 103. Close up view of the construction of one of the bays forming part of group 2468, part of the north coke oven battery. Note the reddened appearance caused by intense heat.

Plate 104. North Coppée oven battery, wider view of brick channel group 2468, with the mouth of flue 2447 visible at the bottom right of the photograph. View to south.

The brick channel into which the bays opened had originally provided access to the mouths of three separate circular flues in the north side of the structure. One of these had been blocked during its lifetime although the remaining two were open at the time of the demolition of the works (Plate 105). These flues, and the system of which they were a part, are discussed below.

Plate 105. North Coppée oven battery, the mouths of three secondary flues which were open to channel 2480. Note the centre flue (flue 2449) had been blocked during its lifetime. Flue 2448 is on the left and flue 2453 is on the right. View to north.

North coke ramming engine wall/structure

Coppée coke ovens were generally furnished with a coke ramming engine to aid in emptying the ovens once the coking process was complete. These engines consisted of a travelling steam engine on a set of rails positioned behind the coke ovens. The engine powered a long ram, moved by a cog engaging teeth along the length of the ram to push coke from the oven onto the coke bench, where it could be hosed with water to arrest combustion. Any pieces of coke remaining in the oven were pulled out by workmen using long rakes or rabbles. By using the ramming engine, the whole process of removing the coke and replenishing with coal for the next coking could take as little as eight minutes. By contrast, the same process using a conventional, non-Coppée coking oven could take one hour. This represented a considerable saving on both labour and loss of heat from the ovens through prolonged periods where the doors had to remain open for removal and re-charging by hand. As has been mentioned, the earlier Thomas ovens at Cyfarthfa were apparently also equipped with a ramming engine and the method would have been familiar to the workers there.

The remains of the support for the north Coppée oven battery's coke ramming engine were found adjacent, and parallel to, the line of the main gas flue. Essentially the remains consisted

of a series of four masonry and brick walls (2323 to 2326) forming the sides of a rectangular 'box' 33.8m long and 9.3m wide and oriented with its long axis running west to east. The resulting hollow space had been filled with demolition material, but the uppermost surface was absent on excavation and had probably been destroyed on de-commissioning of the site. All four of the walls survived to a height of between 1.3m and 2.2m and had been built over the demolished remains of the earlier Thomas ovens; the act of filling the 'box' with material had preserved the remains of these coke ovens and a small section of stone tramway sleepers (group 2384 see Phase 2 section). The internal elevation of all four walls was furnished with a step which demarcated a change in the masonry used for construction; below this line the stones were flatter and smaller, whilst above it larger ones had been employed (Plate 106). All the stonework throughout was irregularly coursed and bonded with a hard, grey coloured mortar.

Plate 106. North Coppée coke oven rammer wall, north elevation of wall 2324 showing constructional differences. View to south.

The north (wall 2326) and south (wall 2324) rammer support walls were pierced with square recess close to the western end, which ran all the way through the wall and positioned in such a way as to be opposite each other. The masonry of wall 2326 had been replaced in this area with red brick, suggesting it was a later addition to the structure. The recess on the south wall (wall 2324) led to rectangular alcove built into the south elevation of the wall at the western

end (alcove 2321). This rectangular alcove measured 3.15m long by 0.9m deep and contained the remnants of two identically sized timber planks, each measuring 1.46m long by 0.32m wide (Plate 107).

Plate 107. North Coppée coke rammer wall, alcove 2321 showing the remains of timber planking and two recesses in the south elevation of wall 2324. View to north.

An additional square recess was located in the south elevation which did not pierce the wall. A basic mortar render had been applied near the alcove but the majority of the brickwork was un-rendered and visible. An annotated map of the works dated to February 1892 suggests that the recesses are close to the location of "coke push out engine No.1" and it is possible these features related to the mounting for an engine that powered the travelling engine along a trackway.

The eastern end of the 'box', wall 2325, also served as a partition dividing this section of the rammer wall from the gas flue system located further to the east. Although the flue structures shared the same orientation and width as the rammer wall, it is unclear how far the trackway for the travelling engine would have extended to the east before becoming obstructed by chimneys.

The space between the partition wall and flue system was occupied by the main gas secondary flue (flue 2338/2432); this flue provided the link channelling gas from the coke ovens to the boiler complex located in the unexcavated area to the north, outside the development area. A probable relieving arch (arch 2391) had been constructed over the flue itself, which may have

acted both as a cooling measure and to carry the weight of any overlaying structure away from the flue; this archway had collapsed onto the underlying flue prior to excavation. Both the surviving elements measured 9m in length, and occupied a space 4m in width. The secondary gas flue had been massively reinforced above its mouth by the construction of a collar of brickwork, at least eight courses thick and bonded with yellow/white lime mortar (Plate 108).

Plate 108. North Coppée oven gas flue system, brick reinforcing collar above the mouth of flue 2338/2432. The grey brickwork in the foreground is part of collapsed relieving arch 2391. View to south.

The only features north of the north rammer wall to be revealed by excavation consisted of a well-made brick floor surface (brick floor 2029) into which an iron plate had been set (Plate 109). Floor 2027 consisted of a rectangular (as exposed) area of yellow firebrick measuring 2.7m by 1.2m. The surface extended to both the north and east but was not fully explored due to the discovery of asbestos in the area. The iron plate (plate 2469) measured 1.64m by 1.16m and was 25mm thick. The plate had been fitted with a separate rectangular plate, serving as an access hatch to chamber 2485 and flue 2486. The refractory brick built chamber beneath (2485) measured 1.54m by 1.06m and had a depth of 1.41m. It provided access to a blocked flue (2486) which was located in the north wall of the chamber (Plate 110). Access to this chamber and the flue was not possible for health and safety reasons.

Plate 109. North Coppée coke oven rammer wall, brick surface 2029 and iron access plate 2469. View to west.

Plate 110. North Coppée coke oven rammer wall, poor photograph of chamber 2485 and blocked flue 2486. Full access to the chamber was not possible for health and safety reasons. View to north.

North battery coke bench

Each battery of coke ovens was provided with a rectangular open space onto which the coke was pushed out of the ovens by the coke ramming engine and known as the coke bench. The hot coke was doused with water in order to prevent further combustion, before being manually dumped into the central storage bunkers between both batteries. The surviving remains of the actual bench itself were limited and consisted of an 8.6m wide by 38.8m rectangle defined by structural walls. This area would originally have been built up and covered by a hard wearing brick surface, similar to the coke bench previously noted for the Phase 2 Thomas Ovens. This surface was angled to allow run off and to aid movement of the coke, as can be seen in the single photograph to survive showing the works in use. Nothing of the actual bench survived except a red brick built trough (2202), which ran parallel to the coke bench and the substantial masonry wall (2199) that formed the north side of the coke storage bunkers (Plate 111). The surviving elements of the brick trough measured 38.9m long by 1.02m in width and had been cut in one place by the run of a modern pipe trench, almost certainly associated with the Thorn Lighting Works. The trough channel formed by the bricks was 0.53m wide and 0.63m deep, and once contained a pressurised water system for dousing the hot coke. At least seven water hydrants are visible along the north coke bench in the contemporary photograph. The inside of the trough contained 22 broadly square, iron stained recesses in the brickwork; together with a stepped area of brickwork at the western end of the trough, these points indicate the locations of fittings for the water pipe, although none related to the probable position of the hydrants.

Plate 111. Brick built trough 2202 that once housed the high pressure water system for the north coke bench. View to north east. Masonry wall 2199, which formed the north part of the coke storage bunker is visible to the right of the trough.

The exterior, north elevation of the trough survived to a height of up to 1.35m, and was very roughly finished, supporting the contention that this elevation was originally buried (Plate 112). The floor of the trough had tilted towards the north, resulting in a canted appearance (Plate 113). This subsidance is probably explained by the nature of the fill that appears to have made up the bulk of material beneath the floor of the coking benches; where it was noted, this appeared to consist primarily of coal dust and clay loam and would have been somewhat unstable over time. That this subsidance ocurred during the lifetime of the coke ovens is confirmed by the presence of a deposit of hard, rust coloured silt along part of the north side of the trough channel, which is likely to have been deposited when the water system was in use (see Plate 113). The subsidance evident in the north trough does not appear to have been as acute as that for the southern coke bench (2201), which showed evidence of remedial repairs during its operational life (see below).

Plate 112. View of the north wall of trough feature 2201. This photograph also shows the insubstantial nature of the material that likely formed the fill for the coking benches, and may explain why both the troughs had subsided.

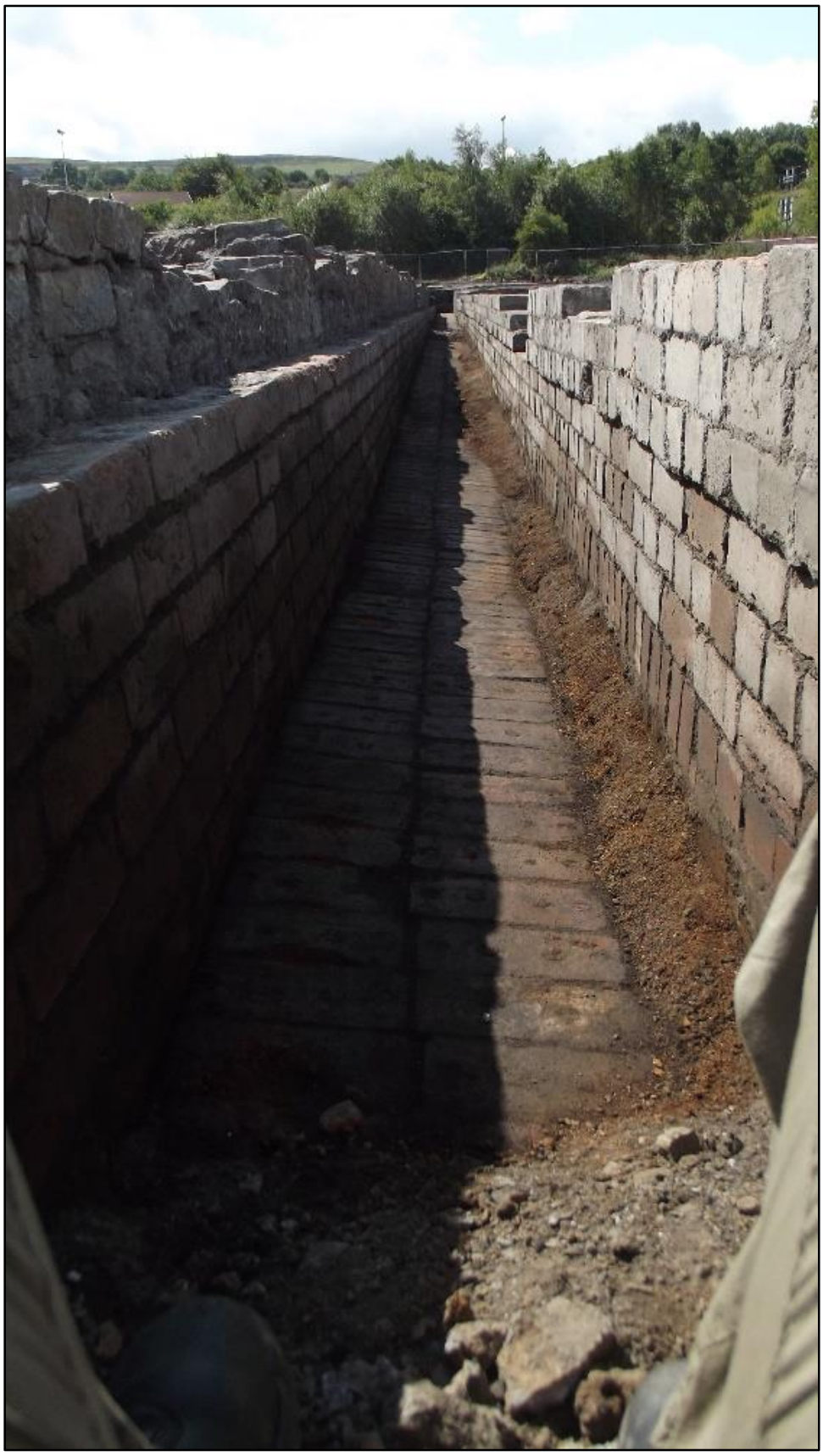


Plate 113. The sloped floor of trough 2202. Note the collection of rust coloured debris to the right hand side of the channel. This suggests that the floor had subsided during the operational lifetime of the coke ovens, but not as severely as 2201 (see below). View to south

Southern Coppée coke oven battery

The vast majority of the south oven battery had been destroyed during construction of the Thorn Electrical Works; photographs taken during construction of the Thorn works show the building overlying the area of the southern coke ovens. As a result, comparatively little of the southern coke oven battery survived. However, enough was discovered to suggest that whilst there were strong similarities in both the north and southern coke oven batteries, there were significant differences in the layout to indicate that the batteries were not simply symmetrical images of one another and there were additional discrepancies between what was recorded on cartographic sources and what was actually excavated. These discrepancies will be discussed further in the conclusion.

South coke battery coke bench

Plate 114. South Coppée coke battery coke bench, trough 2201 looking west. Note that the gap that opened between the trough and wall had been partially filled with brickwork, suggesting that subsidence had been an issue during the operational lifetime of the coke bench.

The remains of the south coke battery coke bench were very similar to those of the north in that they consisted of a brick built trough (2201) backing onto the south wall of the coke bin (2199) (Plates 114 and 115). The base of the trough had slumped away from the adjoining masonry wall during the lifetime of the project, necessitating a filling of the resulting cavity with a line of bricks. The channel had originally measured 0.5m across, backing onto the southern wall of the central coke storage bin (wall 2198). The trough is believed to have held the hose equipment

necessary to douse the coke removed from the Coppée ovens. There were no visible remains associated with the original upper surface of the coke bench.

Plate 115. South Coppée coke oven coke bench, view of the south wall of trough 2201. View to north.

Southern Coppée oven battery

No visible remains associated with the southern Coppée oven battery were noted with the exception of a series of walls and flues described below. These were far lesser in extent than those for the northern battery, and the pattern of survival was far more fragmentary. None of the transverse flue channels located beneath the coke ovens had survived and there were no equivalent flanking walls for the coke ovens as noted for the north battery.

Conversely, the main gas flue for the coke oven battery survived in better condition than its northern partner. Elements of the flue complex for the southern coke oven battery were also recorded, although the majority of any remains in this area remained buried in unexcavated areas outside the main development.

Southern Coke rammer wall

The structure that would have originally supported the coke ramming engine for the southern battery was heavily damaged. Only two sections of masonry walling survived, these being the part of the southern wall of what was probably a rectangular structure, and the other being part of the northern wall.

Comparatively little of the southern coke ramming engine wall (wall 2510) had survived. The remaining element consisted of a 16m long section of pennant sandstone built masonry wall, aligned east/west, with a width of 1.4m and a maximum excavated height of 0.5m; the stones had been bonded with hard grey mortar containing coal flecks. The stones comprising the south elevation were neatly dressed, unlike those of the north, suggesting that the south elevation was

intended to be seen. The masonry had been laid in uneven courses but was not random (Plate 116).

Plate 116. South Coppée coke oven, south elevation of the southern coke rammer wall (wall 2133)). View to east

The northern coke rammer wall consisted of two phases of east/west aligned pennant sandstone masonry walling, (wall 2009 and wall 2133, Plate 118). Wall 2009 measured 23m long by 1.05m in width and survived to a maximum height of 1.1m. The masonry blocks of 2009 were roughly coursed, appearing to be little more than rubble bonded with a friable white/grey mortar. The southern elevation of the wall, where visible, had a neatly dressed face and it is possible that this was the original rammer wall. The north elevation abutted onto a void filled with sandy grit and rubble which appeared to be a spacing layer between the rammer wall and the main coke oven gas flue (flue 2012).

Wall 2133 abutted the south elevation of this rubble wall and appeared much better built, consisting of pennant sandstone blocks with occasional red brick inclusions. This wall survived for a length of 13.4m and a width of 1.08m; it had a maximum surviving height of 0.89m. The masonry was bonded with hard, mid grey coal flecked mortar. The southern elevation of 2133 contained a 0.1m wide step foundation, in the same manner as the northern coke rammer wall. Of particular note was the presence of an apparent construction cut into a clay deposit (deposit 2136) to accommodate the rammer wall. This cut (cut 2135) was one of the few noted through

ought the site and had a very straight edge, possibly indicating it had been machine cut (Plate 117).

Plate 117. South Coppée coke oven battery, useful photograph showing the south elevation of the south main gas flue (flue 2012 at the rear left, and coke rammer masonry walls 2009 (centre) and 2133 (right). The very straight construction cut for the wall (cut 2135) is clearly visible at the bottom of the photograph. View to north.

Plate 118. South Coppée coke oven coke rammer walls, oblique view of the rammer walls and the main gas flue to the rear. This image provides an indicator of the combined width of the wall in this location, which was in excess of 2m. View to north west.

Southern Coppée coke oven main gas flue

The east/west oriented southern main gas flue (Flue 2012) was exposed intermittently for a length of approximately 80m. The feature was similar to that for the northern main gas flue in that it consisted of an ovoid sectioned brick built flue with an arched brick roof (which was absent except at the far eastern end) supported by at least twelve brick pillars down its length. The base of the channel was 2m wide, narrowing to 1.86m close to the spring-point of the arch (Plate 119). A spur to the flue was located 15m from its western terminal, running south at 90 degrees from the main channel. This spur originally had a roof supported by two brick partitions (wall 2281 and 2180) in the centre of the channel and is a further example of a discrepancy between the cartographic sources and the actual structures as excavated. Further exploration of these discrepancies is contained in the discussion.

Plate 119. South Coppée Coke oven battery, western terminal end of the main gas flue (flue 2012). The scale is resting on the course of a more modern Phase 4 pipe trench, view to west

The partition walls showed two phases, with 2281 being the earliest. Both walls had a width of 0.38m and had been constructed of refractory brick bonded with sandy lime mortar. Wall 2281 had an exposed length of 4.98m with a rounded north terminal end, possibly to reduce friction from air flow. The line of this wall had been extended to the north by the construction of wall 2280, which abutted the rounded end of 2281. No similar attempts to introduce aerodynamics had been made, and wall 2280 was a simple, rectangular structure, 1.72m long (Plate 120).

Further excavation to the south of the spur flue was halted due to the presence of asbestos in the overburden.

Plate 120. South Coppée coke oven main gas flue, spur to flue 2012 showing the supporting partition walls 2280 (nearest camera) and 2281. View to south.

Southern Coppée coke battery flue complex

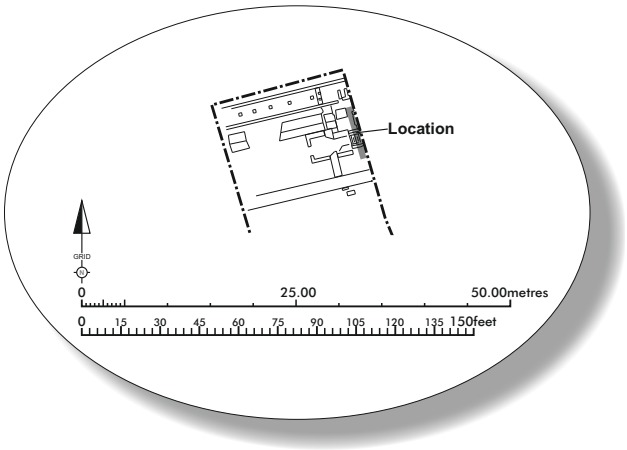
The southern coke oven battery contained a flue complex (Figure 18) which was the equivalent of that noted at the north east corner of the site for the north battery. This complex was, however, heavily truncated and only the lowest levels survived. Combined with the limited extent of the excavation carried in the complex area, the flues associated with the southern battery are less well understood. Essentially they appear to have consisted of a grouping of rectangular brick chambers (features 2557 to 2560) which were the equivalent of brick group 2468 in the northern complex, together with the remains of a possible chimney base (chimney 2509) and secondary main gas flue.

The eastern terminus of the main southern coke oven gas flue (flue 2012) was present as a much damaged but simple vertically sided wall (Plate 121), as was the case for the northern flue. No down-take for the main gas flue was observed, confirming the suggestion that the down-take for the northern main gas flue was present to channel hot gas into the boiler complex depicted on cartographic sources. Due to the extent of the damage to the remains, it is unclear how the gas from the southern ovens travelled from the main flue, into the area of brick bases 2557 to 2560 but the level of vitrification around these features, compared to the northern group, was such that it suggested the gas was indeed hotter and the route therefore likely to be

shorter. Two square recesses (feature 2563) close to the terminus are suggestive of a mounting and it is possible that a grille or similar opening had originally been present (Plate 125).

Plate 121. South coke oven flue complex, eastern terminal end of main gas flue 2012 showing one of the square pillar bases that supported the roof and the brick bay grouping beyond. The level of vitrification was greater here than for the northern flue. View to east.

The grouping of brick bays revealed dimensions comparable with those from the northern grouping, with the recesses measuring 0.27m in width by 1.02m in length. The brickwork which had originally formed the sides of the recesses was absent but the original positions were easily seen due to the pattern of vitrification, which was far more extensive than for the northern group (Plate 122). The central channel (flue 2557) that linked the individual bays also compared favourably, being 0.31m wide. Similarly, the southern flue complex was equipped with at least one smaller north/south oriented flue which connected the brick bays to what appeared to be a secondary gas flue connected to a chimney (flue 2526 and chimney 2509). The mouth of the smaller flue was visible at its junction with the secondary gas flue, revealing the highly specialised nature of the brick used in its construction. One of these was stamped 'Timmis 18 Stourbridge' and more information is available at the brick report below. This junction had been crudely blocked by the positioning of a series of un-bonded bricks at the mouth (blocking 2556, see plate 123) which may be contemporary with the alterations visible within the chimney base chamber (see below).



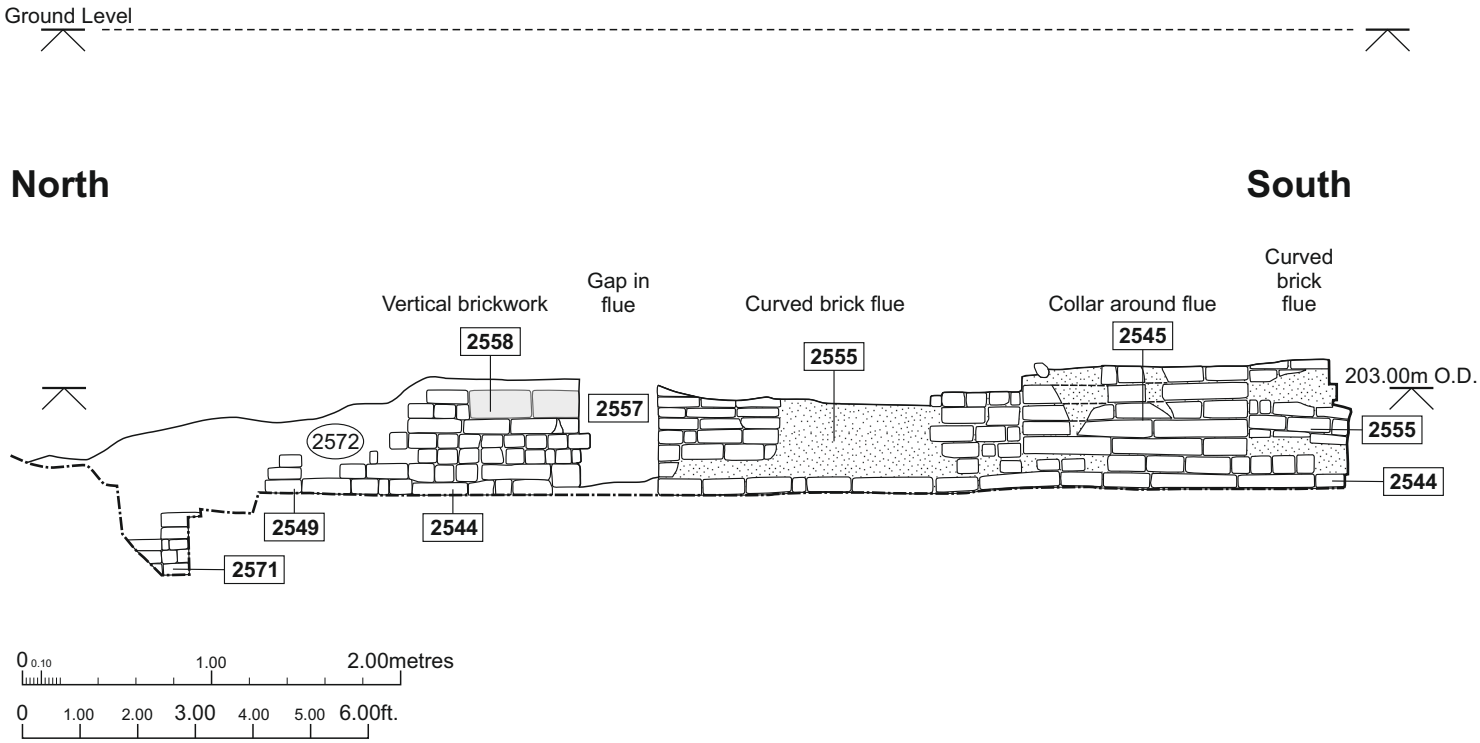


Figure 18. West facing elevation of the excavated southern coke oven battery.

Plate 122. Southern Coppée coke oven flue complex, remains of recesses 2560 (closest) and 2559 visible as heavily vitrified areas of brick. View to east.

Plate 123. South Coppée coke oven flue complex, crude blocking visible at the junction of flues 2555 and 2526. This blocking may be contemporary with the modifications evident in the chimney base chamber (see below). View to north east.

The secondary gas flue (flue 2526) ran parallel to the main gas flue and was located 4m south of it, being separated by the brick bays and attendant smaller flues. 2526 was circular in section, having an internal diameter of 1.51m, and had been constructed from specialist, wedge shaped

refractory brick. The flue was exposed for a length of 5m but the majority remained buried in the unexcavated area to the east (Plate 124).

Plate 124. South Coppée coke oven flue complex, view of secondary gas flue 2526 and chimney base 2509. Note the ridge of accreted material in the centre of the channel and the deliberate attempt to narrow the chimney base chamber. View to east.

Plate 125. South Coppée coke oven flue complex, another view of the eastern terminus of main gas flue 2012 showing the possible mounting for a grille or similar. View to east.

The probable chimney base (chimney 2509) was originally a rectangular feature measuring 4.5m by 2.4m with the long axis aligned east/west. It had been constructed from a combination of masonry and refractory brick with a wall thickness varying between 0.5 and 0.3m. The base contained a high ash content rubble fill (fill 2519 and 2520) on excavation as well as numerous re-used red coloured refractory bricks. An attempt had been made to reduce the width of the base by the crude placing of some of this rubble to form two un-mortared divisions (see plate 124). This effectively narrowed the width of the chamber to 1m, although the actual original extent or function of this blocking is unclear. Of note, however, was the presence of a triangular ridge of concrete apparently underlying the blocking; this concrete ridge coincided with the centre line of a pipe trench (cut 2523 and pipe 2524) which had made use of the course of the secondary flue to lay a brown ceramic pipe. It is therefore likely that the blocking of the junction of flues 2555 and 2526, together with the modifications seen in the chimney base, were done at the time of the construction of the Thorn Lighting works in 1947.

A wedge shaped breach in the north coke rammer wall in the same area (cut 2530) is likewise almost certainly associated with the construction or demolition of the Thorn works as the fill contained steel rods, concrete waste, brick and stone (fill 2546).

The coke rammer wall itself shared the characteristics of the section that was visible further west, namely that it consisted of a double skinned masonry wall (wall elements 2537, 2570, 2533 and 2534) bonded with coal flecked light grey mortar. The wall had a combined width of 1.95m and although damaged, had an exposed length of 11.1m; very little however survived above the excavated ground level (Plate 126).

Plate 126. South Coppée coke oven flue complex, exposed remains of the north coke rammer wall (wall elements 2537, 2570, 2533 and 2534). The double skinned nature of the masonry is evident, as is the later wedge shaped cut (cut2530) through the wall, associated with either construction or demolition of the Thorn Lighting works. View to east.

Central Coke bin

Once the coke from the Coppée ovens had been doused with water, it was moved by hand into a central row of storage bunkers located between the batteries. The surviving portion of this central coke bin consisted of a rectangular space defined by three, substantial masonry walls (2199, 2181 and 2198). The coke bin itself contained a general demolition deposit (2200) comprising yellow and red brick, masonry blocks, shale, slag and occasional small iron objects such as bolts and washers. This deposit had been tipped into the coke bins on demolition of the works, almost certainly the work undertaken in the early 1920s.

The surviving elements enclosed a space 9.07m wide and 38.8m long, oriented east to west (Plate 127). All three walls were of the same construction, being made of generally rectangular, grey sandstone blocks bonded with hard, grey coal rich mortar. The quality of the stonework was good, with the joints between the irregularly coursed stones being well made. The blocks themselves varied in size from 0.07m by 0.05m to 0.56m by 0.17m and the walls had an average thickness of 0.67m. The upper courses of the walls were missing but otherwise the condition was good, having benefitted from being buried. Initially, the walls were only exposed to a height of 1.8m, but on final ground reduction, demolition fill 2200 was removed, exposing the walls to their approximate base and revealing a surviving height of 5.2m. Both the north (2199) and south (2198) walls of the coke bin contained a 0.6m wide recess to house a vertically mounted cast iron pipe, made of separate sections bolted together (Plate 128). The function of these pipes is unclear, particularly as they appeared to have been capped or terminated at the upper end; nothing is visible on the 1890s photograph of the coke bins that suggests what they were used for. Both the north and south walls also contained a number (in excess of 27 on each side) of rectangular recesses, each containing an iron box insert measuring 0.15m by 0.35m and spaced apart at widths ranging from 0.4m to 0.6m. These recesses were arranged in a horizontal line 2.35m below the surviving level of the walls (Plate 129). Again, the function of these recesses is unclear but it is possible they may have supported a framework for a floor level within the coke bins. This would have permitted space beneath the floor for a system of trap doors and dandies that took the coke from the bins to the furnace tops, although no evidence of this flooring was found. It is difficult to imagine how else such a system would have worked if there was no false floor to the bins and the inserts are likely to represent the only visible remnants of this floor.

Plate 127. General view to the west of the central coke bin formed by masonry walls 2181, 2198 and 2199.

Plate 128. The vertically mounted iron pipe set within the recess in the north coke bin wall. View to north. Note also the smaller recesses fitted with iron box inserts, which probably supported a false floor within the coke bin area.

Plate 129. Closer view of the horizontally arranged floor supports in the south wall of the coke bin (2198). View to south

The west wall of the coke bin (2181) was furnished with two recesses containing iron lintels, which appeared slightly larger than those in the other two walls, and which were set 2.2m below the surviving level of the wall top. These recesses were 0.65m in height but the width could not be measured due to access restrictions. It is likely that these too were supports for the floor of the coke bin. The outer face of an arched recess constructed of yellow refractory brick was noted at the centre base of the west wall (Plate 130). The feature could not be examined due to safety reasons but may to relate to the incline system that was used by the dandies to transport the coke. The upper section of the culvert was located at 3.8m below the surviving level of the west wall, with the lower section being obscured by debris. There was a suggestion that a rail survived at the base of the bins but again, this could not be examined due to safety concerns.

Plate 130. View of the west wall of the coke bin (2181) showing the damaged recess that was probably part of the transport system for moving the coke from the bin to the furnace tops. View to north west

No evidence was noted to indicate the location of the partitions visible in the 1890s photograph. These appear to have been of brick construction held within a probable iron frame. It is possible that the entire system was, in effect, a box liner system supported by the iron inserts and which would therefore have left little trace.

Phase 3 summary

The bulk of the recorded remains dated to the period 1882 to 1926, and comprised the remains of the Coppée coke ovens and attendant coal washery and crushing plant. Only the foundations of these features survived, although it has been possible to fairly accurately identify each of the structures, and their function, with the exception of the coke oven flue complex. Two phases of construction are visible in the washery/crusher area as well as the storage bunker area to the west of the Coppée ovens. Phasing for the ovens themselves was rather less clear cut and it was obvious that some re-modelling had taken place, specifically within the area of the north flue complex.

7 Phase 4. 1926 to present

Thorn Lighting Works

The Thorn Lighting works was constructed in 1947 in order to meet the expansion requirements of a successful lighting lamp making subsidiary of Thorn, Atlas Lighting. A small number of photographs survive which show the development area prior to construction of the works. These show an open area largely consisting of coal dust and mud, with numerous discrete areas where brick has been piled (Plates 131 and 132). It is believed that the photographs show the area immediately prior to the commencement of construction as there is no evidence of undergrowth or other vegetation which would surely have taken hold in the years following demolition of the works in 1923. This is confirmed by aerial photographs of the site taken in the 1930s which still show upstanding areas of building, notable elements of the coal washery and brickworks, which appear to have survived the official demolition, as well as extensive undergrowth. It is unclear as to whether these remains were flattened as part of the construction of the Thorn Lighting works but the extensive brick deposits shown on the 1947 photographs suggest that this was the case.

Plate 131. View to the north west across the development area taken in 1947 prior to construction of the Thorn Lighting Works. Note the extensive deposits of brick and stone and the absence of vegetation, suggesting recent demolition of the final remains of the coke and brickworks. The photograph was taken from the historic spoil heap that dominated the southern part of the Cyfarthfa site, with the smithy area being located close to the centre right of the image. (Alan George)

Plate 132. View to the south east across the development area taken in 1947 showing recent demolition. Note the historic spoil heap in the middle distance and the possible remains of the associated engine house at the right edge of the heap. The same spoil heap can be seen from different angles in photographs of the 1890s, shown elsewhere in this report (Alan George)

One photograph appears to have been taken from the base of the storage bunker between the two former coke benches and shows the Thorn works dominating the upper level of the south coke ovens (Plate 133). This is strongly supportive of the idea that the south coke oven battery was severely truncated by the construction of the works and accounts for the differential survival of the same compared to the north battery.

Due to the success of its operation, the Thorn Lighting works were expanded soon after opening, with further significant expansion occurring in 1965. Much of this change was due to the introduction of new plant and may not necessarily have led to major physical extension of the works footprint. The business went into decline following the death of its founder Sir Jules Thorn in 1980 and a succession of mergers and buy-outs did little to tackle the fundamental difficulty of overseas competition. The works finally ceased production in September 1992 and the works were demolished in early 1993. Several photographs exist of the demolition of the works at this time which confirms the fact that nothing of the original Cyfarthfa works was visible.

Plate 133. Photographs of the Thorn Lighting works under construction. The engineered break in the massive masonry walls is, in fact, the outlet for the storage bunkers between the two coke oven batteries. The image strongly suggests that construction of the Thorn works accounts for the extensive truncation of the southern coke battery when compared to the north. View to south (Alan George).

Miscellaneous features

Twin brick chambers 2341 and 2309 contained by cut 2310.

Two rectangular brick built chambers were noted, one (chamber 2309) in the area of the north Coppée oven coke bench, the other in the area of the Thomas oven coke bench. Both chambers had internal measurements of 1.8m by 0.7m and had their long axes aligned north west/south east. Chamber 2309 had an excavated depth of 1.33m, revealing an arched probable culvert covering a span of 0.84m. Concrete and brick elements for the chamber had then been built, and the trench backfilled with a brown and black deposit containing frequent stone inclusions.

Chamber 2309

The bricks used in the construction of chamber 2309 were frogged, red coloured and bonded with dark grey coal rich mortar. The chamber itself appeared to have been positioned to sit astride the line of the former first phase canal, and indeed, on further excavation, one section of the probable stone canal wall was uncovered (Plate 134) The canal itself appeared to have been capped by a horizontal roof of yellow refractory brick bonded and rendered with a thick mid grey mortar. The construction cut for the chamber (cut 2310) was clearly visible as a diagonally sided cut through an almost pure coal dust surface and, in places, had been cut

through part of the possible natural clay ground, which had an orange colour, unlike that noted in other areas of the site, which was yellow in colour; it is possible that the clay associated with the construction cut had been re-deposited. The space between the cut and the structure had been packed with rubble (Plate 135). An apparent drain or similar made of two rows of brick laid edge down was noted at the base of the packing material but the purpose of this was unclear.

Plate 134. North Coppée coke oven coke bench, cut for modern brick chamber 2309.

Plate 135. North Coppée coke oven coke bench, construction cut 2310 showing the rubble packing and the cut through a coal dust layer and possible re-deposited clay. Note the drain like feature at the base of the cut. View to south.

The capping for the canal feature appeared to underlie the brick trough that had contained the watering hose system for the north coke bench and it is possible that the chamber was a method of utilising any water still carried by the canal to help supply the prodigious quantities of water that would have been required to douse the coke as it came out of the ovens. However, there is no evidence on the historic photograph of the coke bench of an access to any chamber. Furthermore, although not completely excavated, the interior of the chamber itself proved to be absolutely dry and showed no evidence of ever having carried water. The capping over the canal appeared to be later than the construction cut for the flanking wall of the north Coppée battery (Plate 136) but this does not mean the feature is not broadly contemporary.

Plate 136. North Coppée coke oven battery, chamber 2309 and the capping over the canal. Note that these features have cut the construction cut for the south retaining wall of the coke ovens (construction cut 2300).

No similar system of chambers and capping was noted for the south coke oven battery although this area of the site was more extensively truncated.

Chamber 2341

Chamber 2341 was constructed in a virtually identical fashion within the footprint of the northern coke rammer support structure. The chamber was built of frogged red brick bonded with light grey lime based mortar. The chamber was oriented north/south and measured 2.55m in length by 1.45m in width; it was not exposed to any great height, surviving to a maximum of two courses where seen (Plate 137). The interior was filled with demolition material and remained unexcavated but it is likely that the interior contained an arched channel as in the case of 2309. Chamber 2341 possessed a rather poorly defined construction trench which had cut the coke bench for the Thomas ovens (surface 2372) but there was no sign of the construction cut having followed the course of the earlier canal, as was the case for 2309. The positioning of chamber 2341 would place it within the probable centre line of the trackway for

the coke ramming engine and it is therefore highly likely that the feature is later than the period in which the ramming engine was in operation.

Chambers 2309 and 2341 are believed to relate to Phase 4, *i.e.* they post-date the operational phase of the coke works and are most likely to be associated with the Thorn Lighting works.

Plate 137. North coke rammer wall area, brick chamber 2341 showing the poorly defined constriction cut through the Thomas oven coke bench. View to east.

Inspection manholes

Two modern manholes were recorded which appear to have been built as part of the Thorn Lighting works. These were clearly much later in origin than any of the preceding phases and generally isolated from any contemporary features. They are therefore described individually within this section.

Manhole 2034 (Plate 138) was located straddling the south east wall of the structure housing the Carr's disintegrator. The manhole consisted of a red brick built chamber measuring 1.05m square; the internal area measured 0.6m by 0.56m and bonded with a white coloured concrete mortar. The surviving height of the chamber was 1.3m but the chamber was filled with debris, preventing an assessment of its full depth. The construction of the chamber had destroyed part of the south east wall of the disintegrator structure, providing basic phasing evidence.

Plate 138. Manhole 2034, which had truncated the south east corner of the Carr's disintegrator building. View to north.

A further manhole/inspection chamber, 2139, had been built adjacent to the main flue of the southern Coppée oven battery (2011). The structure measured 1.2m by 1.14m and as exposed to a height on 0.95m above the ground surface. The feature had been constructed of red bricks stamped with "NCB Tredegar" and bonded with a clean grey concrete mortar. The brick element had been built onto a concrete base which was at least 0.1m thick, and the south part of the chamber had been cut into the north wall of flue 2011 (Plate 139).

Plate 139. Inspection chamber 2139 cutting the north wall of the main flue for the southern coke ovens. This was almost certainly part of the Thorn Lighting works. View to east.

The bricks used in the manufacture of the manhole were manufactured by the former Tredegar Iron and Coal Company's brickworks. Their bricks had formerly been stamped "TIC and later simply Tredegar" but on Nationalisation of the colliery and brickworks in 1946, the bricks were stamped "NCB Tredegar" (Penmorfa.com). Thus a relatively modern date is certain for the inspection chamber and a 1946 attribution for the bricks fits very well with the construction of the Thorn Lighting works in 1947.

Phase 4 summary

Very few remains from phase 4 were noted, which indicated both the extensive nature of the demolition of the Thorn Lighting works in 1993 and preparation of the ground prior to commencement of the archaeological works. Only the very deepest structures such as drainage features were present, and none of these were significant in themselves. However, the re-use of features related to the coke works, such as flues and water channels suggested that a certain level of corporate knowledge remained in the Merthyr area concerning the layout of the coke works, and it is possible that at the time of construction of the Thorn works in 1947, drawn plans of the former coke works were still in existence that have subsequently been lost or destroyed.

8 Specialist artefactual and environmental assessments

Following completion of the fieldwork all bulk finds were sorted and cleaned, re-packaged in labelled bags and stored in labelled museum storage boxes. All finds, including small finds, were quantified by type and context, and this data, along with the sample data, entered onto a computerised database (Microsoft Access). The assemblage was then submitted for specialist assessment. Pages 180 to 210 present the resulting specialist reports.

No small finds were recorded and no samples for environmental analysis were taken. The artefactual and environmental assemblage is summarised in Table 1.

Table 2. Finds and environmental assemblage summary

Category	Bulk finds	Small finds	Samples
Animal bone	22		
Brick/tile			68
Ceramic object	75		
Clay-pipe	29		
Coal			
Coins			
Coke/Clinker			
Copper alloy	2		
Environmental samples			
Flint/Chert			
Glass	42		
Iron	366		
Leather			
Modern Synthetics	5		
Mortar samples			25
Other			
Other metals (Pb, Cu etc.)			
Pottery	115		
Shell			
Slag/other industrial			
Stone Artefact			
Stone tile/slate			
Structural Stone			
Unworked Stone			
Wood			

Pottery and glass - Joyce Compton (Freelance)

Post-medieval and modern pottery

Introduction and Methodology

The pottery recovered from work at Cyfarthfa coke works forms a small assemblage amounting to 122 sherds, weighing 1207g, most of which is un-stratified. All of the pottery has been recorded by sherd count and weight, in grams, by context, and the data entered onto an Excel spreadsheet for ease of manipulation. The spreadsheet forms part of the archive. The assemblage is fragmentary (average sherd weight 9.9g) but, although fragmented, is in relatively good condition, apart from several sherds which are coated with a black deposit (possibly tar) and others with heat damage.

Descriptions and Dating

More than three-quarters of the assemblage comprises modern ceramics dating to the 19th and 20th centuries. White earthenware is the largest component, mostly with blue transfer-printing but there are occasional sherds with brown or orange. Several sherds have pink lustre wavy-line decoration; others have blue stripes. Also present are mocha wares, common in public houses before the advent of glass beer mugs, and yellow-glazed kitchen wares. No makers' marks were noted. Two fragments of modern white-glazed bathroom tile were also recorded and a small sherd of grey stoneware, probably from an inkwell.

There are remains of two ornaments, the first is un-stratified and from a moulded figurine in grey stoneware, depicting the lower portion of a skirted female figure. The second is a finer example, retrieved from 2132, and comprises joining sherds from a Staffordshire-type ceramic figurine, depicting a male figure in blue breeches and waistcoat seated on a wooden tub. The figurine is missing its head and most of both arms, but is likely to represent the nursery character Little Boy Blue.

Earlier pottery types are present in small amounts, primarily local coarse ware and North Devon gravel-tempered ware. The latter are probably derived from finer vessels, such as jugs, rather than large pans. Both pottery types have a date range of 16th to 19th centuries. A West Country or North Devon slipware jug or pitcher handle (17th/18th century) is also present.

Post-medieval and modern glass

Introduction and Methodology

The post-medieval and modern glass amounts to a total of 44 sherds, weighing 2033g. All of the glass has been counted and weighed (in grams) by context and type, and the data entered onto an Excel spreadsheet which forms part of the archive. The assemblage is dominated by bottle glass of all types, representing 98% by weight of the total.

Descriptions and Dating

Bottles

More than half of the bottle glass assemblage derives from blue-green bottles, representing 19th or early 20th century mineral water or medicine containers. Some sherds are embossed with Hansards Aerated Waters, Merthyr, another has J A Bailey just above the base. Hansard's factory was in Castle Street, Merthyr; J A Bailey was a merchant with premises in Alexandra Road, Swansea. There are also sherds embossed with Hancocks, Cardiff (and see below). A complete cylindrical bottle, used perhaps for ink or quack medicine, was found un-stratified. This has a sheared lip which helped to secure a cork closure; the dried-up cork is still within the bottle.

Two complete crown-top beer bottles in brown glass came from 2132. Both are embossed Hancocks, Cardiff & Swansea; Hancocks' brewery firm was set up in Cardiff in 1884 and soon had branches in Newport and Swansea. Crown top closures were patented in 1892. Ten body sherds of dark green glass, deriving from beer or wine bottles, were recorded. Colourless sherds are few and include the lower half of a fish or meat paste jar. An un-stratified, green wine bottle rim sherd is dated to the second half of the 18th century, using the typology in Morgan (n.d.). This sherd is in poor surface condition and appears to have suffered from heat damage.

Window glass

There are three sherds of un-stratified modern window glass; two small colourless sherds and a blue-green sherd with a moulded design on one surface, probably an aid to obscuring vision.

Object

This is a corner rim sherd from a shallow vessel in yellow-green glass. The external surface has an all-over moulded 'checkerboard' design of raised small squares. The function is not readily apparent, but is reminiscent of the sort of tray once seen on ladies' dressing tables for holding hairpins and the like.

Conclusion

Much of both assemblages is un-stratified and dates to the 19th and early 20th centuries. The stratified components are of similar composition and date. All of the earlier post-medieval pieces are also un-stratified. Neither assemblage appears to be contemporary with the operational coke works and is equally unlikely to derive from the later Thorn electrical works. It may be notable that the glass is almost entirely composed of bottle sherds, but the whole collection has the appearance of an accumulation of rubbish originating from elsewhere.

Reference

Morgan, R, n.d., *Sealed bottles: their History and Evolution (1630-1930)*, Midlands Antique Bottle Publishing, Burton upon Trent

Metalwork – Dr Tim Young (Geo Arch)

The site has produced 366 metal objects during both the excavation and subsequent watching brief. A high proportion of the objects were not recorded from stratified contexts and many were recovered from the scrap metal from the groundworks crushing plant following mechanical overburden removal. Structural metalwork from the re-use of the site during the mid-late twentieth century was excluded from the investigation as far as possible.

The assemblage described here is mostly material that was associated with the coking plant of the steelworks period (1882-1919); a few pieces are derived from earlier use of the site.

The majority of the pieces are not identifiable to particular uses, being relatively 'stock' items or forms. The more specific items include a series of cogged wheels, probably from roller crushers or breakers. Such roll crushers may have been a component of the 1882 crushing plant, rather than the 1894/5 washery that largely replaced it. The washery was represented by several large castings that were probably basal supports for the internal conveyors. Structural ironwork was also present, as were items from the water supply.

Items relating to transport formed a significant group, with items derived from both standard gauge and light railways, as well as wheel from a hand cart and a wheel barrow. A few items from the plateways of the pre-steelworks period were also recovered.

Tools included pieces that would have been employed in the coke works, including large spanners, long handled tools, a shovel and a possible rake, as well items usually associated with mining, such as a mandrel, a wedge and prise bars.

A full copy of the report and recommended illustrations is contained at Appendix II to this report.

Discussion

The metalwork assemblage from the site was largely disturbed from its original location – either within demolition deposits or removed from the site by mechanical excavation.

The majority of the items were derived from the structure of the coal washery and crushing plant, the transport infrastructure and the water supply. There were very few items derived from the machinery of the plant and possibly none at all from the Coppée ovens. This suggests that the demolition and salvage of useful metal was thorough.

It may be significant that the drive wheels from a coal breaker or crusher (Cat. #349-352) are some of the very few pieces of the heavy plant recovered. Wear on cogged drive wheels in such a dirty environment may have necessitated their replacement, so these wheels were not necessarily an active part of the plant at the time of disuse.

Other heavy castings from the machinery (e.g. Cat. #300301) appear to be associated with the lower ends of conveyors from the washery, and so may have been abandoned in their below ground level settings.

The large structural box-work and girder castings of the assemblage are likely to have remained in situ in the building remains until disturbed by the constructional groundworks.

The water supply system for the plant comprised, at least in part, distribution via cast iron pipes with control valves produced by Blakeborough & Sons of Brighouse (Cat. #321323). None of the valves was retrieved under archaeological conditions, so it is not known whether this water system was part of the 1880s works or the 1890s washery.

The assemblage is interesting, for it largely dates to within the period when bulk steel was gradually supplanting wrought iron as the construction material of choice (indeed, the introduction of bulk steelmaking was, of course, the purpose behind the construction of the Coppée coking works). Very few pieces of the assemblage are, however, actually made of steel; most of the metalwork is still of either cast or wrought iron. Most of the fastenings (nuts, bolts etc.) are still apparently hand-made.

There are, however, glimmers of modernisation when compared with the mainly slightly older assemblages from the sister Ynysfach Ironworks and the Ffos-y-fran project (GGAT forthcoming). There are slightly more objects of steel, there is a greater use beginning to be made of hex-headed bolts and nuts and the internal plateway system of the Cyfarthfa Ironworks has finally (by 1882) been replaced by edge rail systems.

As seen on those other sites, the edge rail systems (both standard and narrow gauge) have produced large quantities of screws, bolts, spikes and fishplates during track laying, replacement and final removal, which dominate the transport component of the assemblage; there are very few of the larger items of rails or chairs.

As well as the railed transport systems, the site produced wheels probably cart from a hand cart and a wheel barrow (Drawings 7 and 8).

Although most of the assemblage is likely to relate to the steelworks period, there is a small proportion of earlier material. Two substantial pieces of iron (Cat. #287-288, Drawings 16 and 17)) may be associated with the earlier coke ovens, one probably a structural support binding, the other a hinged plate of uncertain purpose. The pre-1882 phase also produced evidence for the plateway system adjacent to the ovens, which employed lightweight stone sleepers with an Outram-style plate. A single un-stratified example of an Outram-style channel plate (Cat. #242, Drawing 4) may be indicative of the associated plates. There were also other fragmentary pieces of plateway track, including a complete plate with very narrow integral chairs (Cat. #241, Drawing 3), a pointer fragment (Cat. #243, Drawing 3), and a horned sill (Cat. #244, Drawing 5). The plate and sill cannot be paralleled precisely in examples from other sites, but the late use of horned sills at Cyfarthfa compared with other ironworks has been discussed previously (Young 2014a, 14).

The tool assemblage from the site includes several examples of spanners (Drawings 9 and 10), long handled tools (Drawing 11), a shovel and a possible rake fragment (Cat #265-272, 280, 282, Drawing 12) that may have been employed in the coke works. Other tools, including prise bars, a chisel, a wedge and a mandrel (Cat. #273-278, Drawings 13 to 15) are either mining

tools or for manually processing coal (or perhaps coke) in the stockyard. The slightly larger size of the implements compared with the underground tools from Ffos-y-fran may hint that these tools were or over-ground use.

Recommendations

The assemblage contains a small number of pieces for which both illustration and retention is recommended. Some twenty-two items have been identified in the catalogue (see report in Appendix II) as being worthy of illustration in the site report; these same items should be retained if possible. The illustrations have been attached for reference at the Appendix.

Steelmaking ceramics – Dr Tim Young (Geo Arch)

The material comprises a collection of ten Bessemer converter tuyéres. Nine of the tuyéres are used discards of a type associated with the Cyfarthfa Steelworks (approximately 1882 – 1919) and of which examples have also been recovered recently from the Ynysfach Ironworks and from the Cyfarthfa Ironworks stables.

A single example of an unused short tuyére is of a different design. It is only 227mm in length and bears the usual pattern of nine bores employed at the Cyfarthfa works, but they are only 9mm (three eighths of an inch) in diameter, as opposed to the usual 12mm bores (half inch diameter) employed on other Cyfarthfa Bessemer tuyéres. The purpose of this piece is unknown; it is very much shorter than documented types of tuyére for Bessemer converters and may be either for an unusual converter or perhaps it might be a test piece from the brickworks (Drawings 19 and 20).

Recommendations

The steelworks ceramics are an important addition to understanding and should therefore be retained and deposited as part of the archive in its eventual repository.

Ceramic building material (bricks) Johnny Crawford (GGAT)

Introduction

During the Cyfarthfa Coke works excavation and watching brief, a total of 68 examples of ceramic building material (brick and tile) were retained for analysis. Given the large quantity of this type of material noted on the site, only single samples from significant locations were retained. Un-stratified material was retained only when it was either readily distinguishable though form or identifying features such as stamps. Retained samples were examined visually in order to characterise size and shape, any markings, and colour and texture of fabric. Of the total assemblage, 34 were considered to possess sufficient characteristics for analysis and cataloguing.

The generally accepted evolution of brick types over time in the UK was established over 40 years ago (Harley 1974), but the Cyfarthfa examples fall outside this sequence as they contain significant numbers of specialist industrial brick, manufactured to perform specific tasks. In reality, very little serious academic work has been undertaken on bricks dating to the later industrial revolution and therefore the corpus of knowledge concerning these generally under examined items is, with a few exceptions, rather thin (Campbell 2003). Within a Welsh context, it is fair to say that most classification of brick has been undertaken by enthusiastic amateurs who have made their information available through the internet; the websites Penmorfa.com and Industrial Gwent are particularly useful in this regard. However, the general guidance provided for specialist finds reporting (CIfA 2014) has been consulted with regard to the following report

Observations on the assemblage from Cyfarthfa

Some minor variation in ‘standard’ sized brick dimensions were noted, caused probably by variations in batch manufacture and post-manufacture exposure to heat. These variations are in the region of several millimetres and are not considered significant.

Whilst examination of the mortar is beyond the scope of this brick report, it should be noted that many of the refractory bricks examined retained traces of mortar which had a similar appearance to the fabric of the bricks to which it adhered. This suggests that the bricks were bonded with as chemically similar a mortar as possible to reduce the differential heating of materials within the structures, and thus improve longevity of the structures themselves.

The great number of specialist refractory bricks noted on the site appear to have been left at Cyfarthfa as they were of much less utility than standard sized bricks, in terms of their reclamation and re-use. Millions of standard bricks were reported to have been sent to Cardiff on final demolition of the Cyfarthfa works, but those from the coke ovens were simply unusable for any other application and therefore simply left on site.

Catalogue of brick and tile from Cyfarthfa coke works site 770

N.B. Drawn illustrations of the bricks were considered as a method of recording. However, since colour and discolouration of fabrics was a significant component of the character of individual bricks, it was felt more appropriate to record them using digital photography. Consequently, a photographic archive of the catalogued bricks is available on disc appended to the hard copy of this report.

No./context	Material	Dimensions	Description	Photo frame
041 U/S	Cream coloured granular refractory material. The exposed areas have a granular texture and incorporate fine grit including quartz fragments.	Overall length 250mm, width 145mm. Narrows from 145mm to 108mm. Narrowing approximately half way at 130mm.	'T' shaped brick made of dense cream coloured refractory material. Exterior surface is generally smooth but has striations from the mould. Stamped with the code 'C 13' on a single face. Remains of a hard granular mortar noted on two sides. The flat surfaces are generally scorched by heat, resulting in a patchy dark grey to red brown colour. It is unclear as to whether this is the result of the firing process of caused by heat during use but as the scorching is present on all faces equally, is more likely the result of the firing process.	5402, 5403, 5408
020 /u/s	Yellow granular refractory material containing frequent coarse (up to 3mm size) gritty inclusions.	Rectangular, 120mm x 70mm x 250mm	Rectangular refractory brick of 'standard' size. Unstamped The brick has a slightly convex edge on one long side caused by poor manufacture. One surface retains a wedge of mid grey, coal rich mortar suggesting to was close to the spring-point of an arched structure. Slight scorching to several surfaces caused by the firing process and most of the surfaces contain thin cracks caused during firing.	5404-5407
040 /u/s	Coarse gravel rich fabric fired to a metallic dark brown finish on surfaces. Interior shows a mid-brown colour.	Rectangular 245mm (incomplete) x200mm x 22mm thick	Broken roll top ridge tile, originally 'V' shaped in section with a decorative roll top apex. The hollow section has a diameter of 19mm from an overall diameter of 51mm. The unbroken end has a partial stamp of '1?' with the second figure possibly a 9 or 0. One of very few roofing items noted during the excavation.	5409, 5410
109 /2370	Yellow granular refractory material containing frequent coarse (up to 3mm size) gritty inclusions.	Rectangular 222mm x 79mm x 115mm	Rectangular refractory brick of 'standard' size. Unstamped. One edge is discoloured to a dark red/brown by exposure to heat after firing. Some loss of mass has occurred on this edge with the beginning of vitrification in one corner. The upper and lower surfaces contain traces of yellow coloured lime mortar.	5411, 5412
006/2038	Red brown coloured fabric No obvious gritty inclusions although there is some coarseness to the fabric.	Rectangular 225mm x 73mm x 110mm	Rectangular brick of 'standard' size. The surfaces are generally smooth and regular although there is a 'lip' on one corner suggesting the mould was overfilled at that point. All surfaces except the two long edges retain a coarse mid grey coal rich mortar. Un-frogged and lacks any stamp. Some irregularity in the shape of the rectangle suggests a handmade product.	5413, 5414

No./context	Material	Dimensions	Description	Photo frame
123/2468	Yellow orange refractory dense in mass, no obvious gritty inclusions.	Rectangular 148mm x 105mm x 250mm	Rectangular specialist refractory brick which has some vitrification to one of the ends. All other faces retain traces of gritty yellow coloured mortar, almost identical in colour to the brick itself. The vitrified end has been heat affected to a depth of approximately 40mm. All surfaces of the brick have occasional black coloured heat spots that are likely to have been burned during firing of the brick. It is possible the fabric contained elements with a much lower ignition point which have created the blemishes, possibly coal fragments or mud.	5415-5418
10/u/s	Yellow grey coloured refractory brick containing coarse (up to 3mm) gritty inclusions.	Rectangular 107mm x 85mm x 232mm	Rectangular refractory brick stamped 'King Brothers Stourbridge'. One side retains a wedge of gritty pink/yellow mortar, suggesting it was part of an arch. Isolated heat spots are visible in the surfaces from the firing process. The stamp measures 163mm by 38mm and is in a partially eroded blocky typeface.	5419 - 5421
044/2011	Light yellow/grey coloured fabric, generally homogenous but has flat shaped gravel inclusions.	Rectangular 223mm x 60mm x 110mm	Rectangular refractory brick of 'standard' size stamped with a partially visible five pointed crown. This may be a reference to King Brothers of Stourbridge. The points of the crown are bullet shaped, surmounting an elongated oval shaped circlet and measures 80mm by 55mm. One end of the brick is vitrified, with obvious flow lines visible in the surface. Several surfaces retain a gritty textured mortar, almost identical in colour to the brick. Both larger surfaces contain striations in the fabric which run in several directions and suggest that the brick was brushed several times whilst the clay was still soft.	5422-5426
029/u/s	Very dense fabric pink/brown in colour with a very high quartz content.	Essentially 'T' shaped in plan with a flattened cruciform section. Longest edge is 401mm long with a maximum depth of 190mm. Each projecting part of the 'T' is 120mm by 140mm but there is some shrinkage visible which probably occurred during firing. The section measures 150mm at the widest point.	Highly specialist refractory brick made to perform a specific function. The brick is stamped with the reference code '16 A' with the stamping being uneven. This suggests individual letter and number stamps were used rather than one with the complete code. One of the sectional surfaces is partially vitrified and it is likely this brick was specific to a particular part of a heat related structure. The very high density of quartz within the fabric is probably the reason it was chosen for high temperature use. The surrounding clay matrix was essentially simply a medium for holding the quartz together. Striations are visible on both the flanking elements of the brick which were probably caused on extraction from the mould. The stamp is spread across an area measuring 75mm by 55mm. The stamped face measures 150mm x 150mm x 145mm.	5427-5430
Ref no 726/614 (Evaluation phase –	Generally homogenous yellow coloured fabric with small mixed gravel inclusions. Relatively	Rectangular (incomplete) 305mm x 230mm x 75mm. Boss projects 55mm out from the face and has an outer diameter of 185mm, with the	Highly specialist refractory brick which is incomplete. It consists of a rectangular slab of brick featuring a projecting circular boss with a central hole piercing the whole brick. The boss features gently concave sides and slightly flattened top. One end of the slab has broken off close to the boss to reveal a somewhat poorly mixed fabric. There is a suggestion that the boss	5431-5435

No./context	Material	Dimensions	Description	Photo frame
included for comparison)	smooth finish to external surfaces.	central hole having a diameter of 42mm. The central hole, including the boss measures 131mm in length	itself was applied as a lump of clay before being stamped to create the final shape. The last stage of manufacture was to pierce the central hole down the centre of the boss; the exit hole on the reverse of the brick is somewhat ragged. Although incomplete, it is likely that the broken end of the slab would have had the same dimensions, with the boss being centrally located. The fact that the break has occurred near the boss suggests an inherent structural weakness in the method of manufacturing this particular type of brick, as evidenced by an almost identical break in another example (No.31).	
031/u/s	Generally homogenous yellow brown fabric containing frequent quarts and micaceous inclusions. Fine, gritty texture to the external surfaces.	Rectangular (incomplete) 360mm x 225mm x 73mm. Boss projects 63mm form the face of the brick and is 195mm in diameter. The central piercing is 50mm in diameter and 112mm deep.	Highly specialised refractory brick which is incomplete. It consists of a slab of brick featuring a projecting circular boss with a central hole pierced into the boss; this piercing does not go the whole way through the brick and is believed to be a manufacturing defect. The boss has a rounded profile and features a prominent circular moulding around it which may be related to how the piece was made; there is some evidence that the boss was a later addition. The slab itself has broken near the boss revealing the interior of the central piercing and the section of the boss. It is likely that this particular break pattern was common to this pattern of refractory brick and is likely to represent an inherent design flaw. The pattern of the brick is very similar to 726/614 and its function is likely to have been identical. There are enough differences, however, to suggest that whilst unstamped, both examples are likely to have come from different manufacturers.	0935-0938
015/u/s	Generally homogenous yellow /brown colour, isolated small quartz inclusions	Rectangular 223mm x 105mm x 60mm. Two projecting cones on one side, 50mm diameter, 38mm high.	An ostensibly standard sized brick which is furnished with two projecting, flat topped cones on one side. These cones almost certainly fitted into matching recesses in another brick but no examples of it were recovered. The reverse of the brick is stamped 'HARRIS & PEARSON STOURBRIDGE', the stamp measuring 142mm x 33mm and contained within a rectangular cartouche. Although the projections are clearly designed to allow the brick to lock into place securely, the actual purpose of the shape is as yet unknown.	0931-0934
022/u/s	Dense yellow brown fabric containing frequent quartz inclusions. Relatively smooth finish to exterior surfaces.	Irregular wedge shape. 290mm long x maximum thickness 185mm	Specialist refractory brick which bears marked effects from exposure to high temperature after initial firing, obscuring the nature of the original fabric. The brick is multi-faceted, possessing seven separate faces. All but one of the faces are flat but the remaining one has a slightly concave shape that is likely to have formed part of a curve when combined with other specialist bricks. The concave face is also the one most affected by heat, having a deep red colour and is also the only face not to retain traces of a hard, gritty lime based mortar. It is likely therefore that this face was actively exposed to heat, for example within a coke oven or furnace. The brick is stamped 'HARRIS &	0938-0943

No./context	Material	Dimensions	Description	Photo frame
			PEARSON STOURBRIDGE' and the pattern code number '7' The stamp measures 155mm by 34mm and is contained within a rectangular cartouche. The number 7 is set at a slight angle. It should be noted that another brick of the same pattern could not be used to continue the arc described by the concave face and that this brick was made to occupy a very specific place within the final structure.	
028/u/s	Dense, gritty fabric, highly discoloured by vitrification.	Irregular wedge shape, 260mm x 250mm at widest parts, 170mm thick.	Specialist refractory brick which has been exposed to significant heat after initial firing, resulting in vitrification and adherence of residues to the faces. The brick is multi-faceted, possessing seven faces. Although difficult to visualise due to the extent of vitrification, all except one face is flat, with the remaining one slightly concave in shape. This is also the most heavily heat affected face, and has a blistered appearance with a deep maroon colour. It is likely this blistered face was part of the interior arch of a coke oven. Interestingly, however, only three sides exhibit significant vitrification presenting something of a puzzle as to how this variation was achieved. The remaining sided retain traces of a hard gritty mortar. No manufacturers stamp is visible. However, an almost identical, un-vitrified brick (45) has the stamp.	0944-0946
045/u/s	Homogenous pink coloured fabric containing frequent fine gravel inclusions. Smooth finish to exterior surfaces.	Irregular wedge shape, 246mm x 246mm at widest parts, 144mm thick.	Specialist refractory brick which is in relatively good condition compared to other, similar examples. It is multi-faceted, possessing seven faces. All except one face is straight, with the remaining one being slightly concave. This concave face measures 100mm x 143mm and is probably the 'working' face of the brick, helping to form an arch inside a coke oven. Although the sides retain traces of a light cream coloured gritty mortar, the brick does not show any signs of being affected by heat after initial firing. This suggests that the brick was never used as intended within an actual operational oven or furnace. The brick does indeed exhibit some manufacturing irregularities in shape, being slightly bent along its edge and it is possible that the tolerances required in the construction of ovens meant that is was rejected and discarded. The brick is stamped 'C.K. HARRISON STOURBRIDGE' contained within a rectangular cartouche measuring 153mm x 40mm.	0946-0948
u/s	Homogenous yellow/brown fabric containing occasional brown grit inclusions. Smooth finish to faces but frequent small fissures to surface, indicating the clay	Rectangular 225mm x 110mm x 67mm.	Two examples of a standard non-refractory brick were recovered which were frogged and stamped 'WBI 1946 LTD'. The stamp was contained within a bevel edged, recessed rectangular frog, measuring 56mm x 700mm, recessed 10mm below the face of the brick. The bricks were machine made, with the remains of 'plugs' visible on the reverse side. The frog on the reverse side was shallower but of the same dimension. Both examples were of similar fabric but differences in colour suggested a different batch. The presence of two	0949-0950

No./context	Material	Dimensions	Description	Photo frame
	was not compressed particularly hard.		raised studs next to the manufacturer's stamp on one of the bricks may indicate differences in date or place of manufacture. These bricks were almost certainly used in the construction of the Thorn Lighting Works, which began in 1947.	
117/2139	Dense orange red fabric containing frequent mixed angular gravel inclusions. Generally smooth finish to faces but frequent small fissures to surface, indicating the clay was not compressed particularly hard.	Rectangular 222mm x 113mm x 79mm	An example of a machine made non-refractory frogged brick was retained for examination. The brick features a recessed rectangular frog with rounded corners measuring 164mm x 65mm and recessed 6mm from the face of the brick. The frog contained the stamp 'NCB TREDEGAR'. Extensive traces of concrete based mortar still adhered to much of the brick.	0951
u/s	Dense red/brown fabric with slightly gritty finish to exterior surfaces. Frequent dark red/brown fine gravel inclusions.	Rectangular 125mm x 105mm x 66mm	An example of a machine made non-refractory frogged brick. The brick is stamped 'STAR NEWPORT' and has two star symbols either side of the text. The stamp is contained within a rectangular frog, measuring 172mm x 61mm and recessed 6mm from the face of the brick. The frog on the reverse is shallower and retains two 'plug' marks. The brick retains traces of a fine gritty concrete based mortar. This is typical of the products of the firm and are found throughout South Wales.	0952
u/s	Homogenous yellow brown fabric with frequent very fine, angular gravel inclusions.	Rectangular but broken minimum of 190mm long x 112mm wide x 77mm deep.	Incomplete refractory brick stamped 'THISTLE 3'. A small dog-toothed arrow symbol is located above the S of the word thistle. No mortar is evident on any of the surfaces and this was one of the only bricks of this type recovered. It is a product of the Scottish Thistle works and as such is rather out of place in the assemblage, particularly when considering that South Wales and South West England contained numerous high quality brickworks up until relatively recently.	0953
728/811 (Evaluation find)	Dense orange pink coloured fabric containing frequent mixed gravel and quartz inclusions. Slightly gritty finish to faces.	'T' shaped 226mm x 139mm narrowing to 102mm (20mm either side). 150mm thick. Leg of the 'T' is 120mm long.	Specialist refractory brick stamped with 'KING BROTHERS STOURBRIDGE' and the code 'D 13'. The manufacturers stamp measures 167mm x 40mm and has text with a serrifed font. The code has been hastily applied as evidenced by the fact that the 'D' and '13' are oriented in opposite ways. The brick retains traces of a hard lime based mortar and shows evidence of having been heat affected after initial firing, with area of colour varying from grey to deep maroon. The base of the 'T' shape shows signs of the beginning of vitrification, suggesting this was the area of the brick closest to the heat source. The form of the brick is suggestive of a keystone of some kind although its exact position within a structure such as a coke oven is	0954

No./context	Material	Dimensions	Description	Photo frame
			unknown. This example was one of a number of such bricks recovered (see 020).	
020/u/s	Dense homogenous creamy yellow coloured fabric small mixed gravel inclusions.	'T' shaped 235 x 145mm narrowing to 102mm (20mm either side). 145m thick. Leg of the 'T' is 123mm long.	Specialist refractory brick stamped with the code 'D 13'. There is no manufacturer's mark and the stamps are different to those employed in the very similar brick 728/811. Some traces of hard lime based mortar are visible but otherwise the brick is 'cleaner' than the other example. However, the foot of the 'T' exhibits the same almost vitrified fabric, suggesting it occupied a similar position within the structure. There are minor variations in the dimensions of some of the planes but the width of the leg of the 'T' is exactly the same, suggesting this was the crucial measurement. The brick is likely to have functioned similarly as a keystone (see 728/811). It is possible that this example was also made by King Brothers but the absence of a stamp and difference in fabric suggest that another manufacturer may be responsible, perhaps even the Cyfarthfa Brickworks itself.	0955
030/u/s	Dense grey brown fabric containing very frequent quartz inclusions. Fine, gritty texture to the outside faces but the clay element appears to be only a matrix to hold the quartz.	Cruciform, identical in shape to sample 029 i.e. 'T' shaped plan and flattened cruciform section. Longest edge is 380mm long with a maximum depth of 187mm. Each projecting part of the 'T' is 119mm by 135mm. The central section measures 145mm at the widest point.	Highly specialist refractory brick made to perform a specific function. The brick is stamped with the reference code '16 B' with the stamping being uneven. This suggests individual letter and number stamps were used rather than one with the complete code. Both ends of the brick show signs of vitrification, a pattern that only really makes sense if the brick was used as a spacer or part of the dividing wall between individual ovens or furnaces. The very high density of quartz within the fabric is probably the reason it was chosen for high temperature use. The stamp is spread across an area measuring 70mm by 40mm but the figures and letter are smaller in size than those on other examples. The stamped face, which is broadly square measures 150mm x 134mm.	0956-0959
025/u/s	Dense creamy yellow fabric containing frequent mixed gravel inclusions. There is much less obvious quartz included as part of the fabric than in the other examples of this brick pattern (029 and 030).	Cruciform, identical in shape to sample 029 and 030 i.e. 'T' shaped plan and flattened cruciform section although 025 is incomplete. Longest edge is 325mm long (incomplete) with a maximum depth of 202mm. The surviving projecting part of the 'T' measures 126mm by 154mm. The central section measures 625mm at the widest point.	Highly specialist refractory brick made to perform a specific function. The brick is stamped with the reference code '16'. Whilst very similar, the stamping is not identical to that seen on 029. One of the projecting arms of the 'T' shape has broken off. The very high density of quartz within the fabric is probably the reason it was chosen for high temperature use. The stamp is spread across an area measuring 64mm by 63mm, being almost identical in size and nature to 029. The stamped face, which is broadly square measures 160mm x 160mm. No part of the brick shows any sign of vitrification or of having been exposed to significant heat following initial firing and it is possible that this example was never used, although there are minimal traces of soft white lime based mortar.	0960-0962

No./context	Material	Dimensions	Description	Photo frame
131/2444	Dense yellow coloured fabric containing mixed gritty inclusions. Smooth finish to surfaces except at ends which remain rough to touch.	Rectangular in plan, wedge shaped in section. 302mm x 275mm, section tapers from 110mm to 70mm thickness.	Rectangular slab style refractory brick which has a tapering wedge shaped section. Each of the tapering ends has been left rough, unlike the other faces which were given a smooth finish. This suggests that it was more important that the bricks fitted together better along these larger surfaces than the ends and the rougher nature may have ensured a better bond edge to edge. A single serrifed letter 'H' is stamped into one of the larger faces of the brick, the stamp measuring 40mm x 40mm. It is unknown as to whether this is a code referring to the pattern of brick or a manufacturer's stamp. Bricks of this type were used to construct the large flues associated with the boiler down-takes associated with the northern coke oven battery but this particular example had been used to prop up the iron sheeting covering the terminal end of one of the flues.	0964-0965
011/u/s	Green/yellow coloured fabric containing frequent mixed small gravel inclusions. Smooth finish to faces but has a fine gritty texture where it has broken.	Rectangular but incomplete. 150mm (incomplete) x 152mm x 70mm.	Rectangular refractory brick of non-standard size. Stamped 'KING BROT STOURBRI' but the rest is missing. A lower partial stamp may include the number '1'. The stamp is unusual as each line of text is contained within a narrow cartouche preceded by a slightly decorative circular design. This type of stamp was not noted on other bricks produced by King Brothers recovered from the site. Several other examples of this pattern of refractory brick were noted but most were covered in a hard sandy textured mortar which was difficult to remove and obscuring the stamps.	0966
038/u/s	Dense yellow/pink coloured fabric containing small mixed gravel inclusions including quartz. Smooth finish to faces but has a gravelly texture to broken areas.	Rectangular (incomplete) in plan and shaped like a blunt wedge in section. The central portion of the upper face is stepped up to create a steeper wedge. 280mm x 285mm and 120mm thick, tapering to 62mm.	Wedge shaped specialist refractory brick, which was originally rectangular in plan. The central section is raised, giving a steeper profile to the section. This raised section also tapers slightly with the distance between the edge of the brick and the raised section ranging from 100mm to 110mm. The raised, central section has an incomplete stamp reading 'IS & PE SROURBR' and the numeral '2'. The stamp indicates it was made by the firm of Harris and Pearson. This brick is one of the few that can be identified from its form as being one depicted in a catalogue of brick types associated with the Coppée coke oven (See below).	5442-5444
033/u/s	Dense pink/brown coloured fabric containing mixed small gravel inclusions, Rather rough finish to surfaces with gravelly	Rectangular 350mm x 300mm, 72mm thick. Central hole gas a 38mm diameter.	Specialist refractory brick with a slab like nature. The brick is pierced in the centre by a circular hole with a 38mm (1.5 inch) diameter. The brick is stamped with the code '19 E' but is otherwise unmarked. Both the upper and lower faces retain elements of a hard white/grey mortar suggesting that several bricks of this type were sandwiched together.	5445

No./context	Material	Dimensions	Description	Photo frame
044/u/s	Dense grey/cream fabric containing mixed fine gravel inclusions and frequent quartz inclusions	Rectangular in plan, in section it has a flat base with tapering sides to allow for a concave upper surface. 390mm x 298mm, thickness varied from 150mm to 120mm.	Specialist refractory brick consisting of a rectangular slab which tapers on two sides to allow one surface to be concave in shape. This may represent the top of an arch for either a flue of even the interior of one of the individual coke ovens. The concave face is slightly vitrified and the side of the brick has a colour change indicating that heat has penetrated up to 80mm inside the fabric of the brick. There is no manufacturer's mark or pattern code.	5446-5447
Not known/u/s	Pink/brown fabric with a rather rough finish to surfaces and mixed fine gravel inclusions	Rectangular in plan, the two narrower sides ate bevelled. The holes have a uniform diameter of 25mm. 357mm x 300mm x 95mm thick.	Specialist refractory brick consisting of a rectangular slab with two bevelled edges to produce a wedge shaped section. The slab is pierced by 13 circular holes in five rows, alternating from 3 to 2 piercings per row and back again. A partially visible manufacturer's stamp reads 'BROT STOURB…GE' which in this case refers to the King Brothers of Stourbridge. The piercings were done after the stamp had been applied but before the slab itself had been fired, as several holes interrupt the lettering. The pattern code '351' is stamped on one edge of the brick.	5446-5448
043/u/s	Very dense pink/yellow fabric containing frequent quartz inclusions. Fine gritty texture for finished surfaces.	Irregular rectangle 495mm x 300mm 170mm thick. 'U' shaped cut out measures 190mm wide by 150mm deep but is slightly asymmetrical. One side of the slab is flat, the other is concave in shape.	Very dense slab of specialist refractory brick, broadly rectangular in plan but with a slightly asymmetrical 'U' shaped cut out in one side. The two shorter edges are bevelled, resulting in a wedge shaped section. One side of the slab is flat, whilst the other is concave. The pattern code '20' is stamped on the concave face, which appears to be slightly vitrified. It is possible that this slab is associated with the stoking of the coke furnaces and that two of them would have been used to charge the oven. If so, the hole would have had a combined diameter of approximately 300mm.	5449-5452
034/2281	Sulphur yellow coloured fabric containing frequent large (10mm) quartz fragments. Very rough to touch due to the large size of the quartz inclusions. Fabric when examined was friable.	Damaged. 180mm x 140mm x 110mm.	Incomplete probable refractory brick with a very high quartz fragment component. The brick is sub rectangular and is unusual both for the yellow hue and the large fragments of quartz. The fabric is unlike any other noted in the assemblage. High quartz density has been noted in some of the other refractory bricks used but the fragments tend to be small, in the region of 3mm-5mm. It is unclear why the fragments in this example are so large, as they appear to have contributed to the friable nature of the final brick.	5453-5454
083/2284	Yellow/cream coloured fabric with fine mixed gravel inclusions. Slightly gritty texture to finished surfaces.	Rectangular 225mm x 110mm x 62mm thick.	Representative 'standard' sized refractory brick. The brick retains traces of hard, gritty yellow cream mortar and the brick has a partial stamp '& Co. … OURBRIDHE' as well as the numeral '6'.	5455-5456
106/2369	Red/brown coloured fabric fairly homogenous in	Rectangular 229mm x 110mm x 80mm thick	Rectangular refractory brick from the Thomas ovens. The brick is un-frogged and unmarked and has been made slightly thicker than other 'standard' sized	5457-5458

No./context	Material	Dimensions	Description	Photo frame
	nature. Slightly rough finish to surfaces.		bricks. One edge is vitrified, suggesting it was laid edge on for improved strength. The brick retains traces of a gritty, slightly friable lime based mortar and has a slightly irregular appearance, suggesting a hand-made product.	
108/2372	Very light creamy yellow fabric containing relatively large (3mm-7mm) frequent mixed gravel inclusions. Slightly rough finish to surfaces.	Incomplete rectangular 212mm x 114mm x 67mm thick.	Rectangular refractory brick from Thomas ovens. The brick is un-frogged and unmarked but one end is vitrified but the extent of vitrification is relatively shallow, only being 3mm or so thick and no discolouration of the brick fabric present. This may suggest that the temperatures achievable within the Thomas ovens were not sufficient for the much more extensive vitrification visible in bricks associated with the Coppée ovens. The brick has a slightly irregular appearance, suggestive of a hand-made product.	5459-5460

Discussion

Most industrial activity in South Wales was associated with both the use and manufacture of bricks. The occurrence within the Coal Levels of suitable clay deposits interleaved with coal seams meant that clay was a by-product of mining, and indeed it was not unusual to find mines being operated after the coal had been exhausted, for the extraction of clay for bricks. The majority of ironworks, including Cyfarthfa, operated its own mining network in tandem with iron production and as a result, often operated their own brickworks. However, these brickworks were usually managed within the host coal mine company and as a result are poorly documented, and the survival of recognisable stamps on the bricks themselves are often the only firm indication of their provenance; this is the case with brick assemblage from Cyfarthfa.

Only a single example of roofing material was contained within the assemblage. Contemporary photographs of the coal washery indicate a roof made of corrugated iron and it is likely the majority of the buildings in the area would have had roofs of similar construction, meaning that the requirement for ceramic roofing materials was potentially low.

In the main, the bricks can be divided into two general categories, refractory bricks and constructional bricks.

Refractory bricks

Specialist refractory bricks, which tend to have a creamy, yellow coloured fabric, were manufactured as special bricks in order to create sacrificial linings for structures subject to intense heat, including brick kilns, coke ovens, furnaces and chimneys. One of the properties of refractory brick fabric is that it can withstand repeated heating and cooling without becoming fractured, and therefore brick linings will survive intact for some time. They only lose their structural integrity when heated to melting point, and even then will survive intact. Ten of the specialist refractory bricks in the assemblage were manufactured in the Stourbridge area, with two manufacturers being particularly prominent, King Brothers and Harris and Pearson. The remainder of the specialist bricks were unstamped. Whilst all these bricks were un-stratified, there is little doubt that they were used within the Cyfarthfa Coppée coke ovens and its associated structures. It is likely, therefore, that the bricks bearing stamps were bought from the Stourbridge companies for the initial construction of the coke ovens.

It is clear from contemporary documentation that the brickworks constructed at the same time as the Coppée ovens at Cyfarthfa were eventually able to supply the need for specialist products, but the initial build was almost certainly carried out with the Stourbridge products. It is possible that the unstamped examples of specialist brick were manufactured at the Cyfarthfa site and that there was no perceived need to stamp

products that were to be used within the works, but there is no direct evidence to support this. Whilst CYFARTHFA stamped standard sized firebricks are known from South Wales (Penmorfa 2017), not a single example of a Cyfarthfa stamped brick was noted in the assemblage. There were, however, unstamped bricks aplenty. It would be remarkable if the coke ovens were not utilizing bricks manufactured literally next door and this supports the idea that products intended for internal consumption, including the more specialised types, remained unstamped.

Standard sized refractory bricks were evident in the assemblage, the majority of which were un-frogged and unstamped. These bricks almost certainly date to the operation of the Cyfarthfa works but no later and are therefore likely to pre-date 1919.

Constructional bricks

Constructional bricks *i.e.* those intended for general building, tended to be a variation of orange/red in colour, indicating a higher iron oxide content. The fabric was unsuitable for applications requiring high temperatures but were used for everything from building walls and foundations to propping up boiler vessels. Constructional bricks would have been made in their millions and as the vast majority of constructional bricks noted on site were un-frogged and unstamped, the information that can be obtained from them is somewhat limited; dating of the bricks is likely to be based on context alone.

Notes on the manufacturers identified at Cyfarthfa.

Thistle brick.

Thistle was the trade name of a high alumina (38%) content brick manufactured by Scottish company JG Stein in the Castlecary/Bonnybridge and Linlithgow area, near Falkirk. The company manufactured high quality refractory products although under a different name, and Thistle bricks have been found as far away as Tasmania and South America. A single, un-stratified example of a Thistle brick was noted and its presence is somewhat unusual. However, bricks manufactured by the same company with the trade name Nettle have been found in Ebbw Vale and Cwmbran, in association with works owned by GKN, who appear to have sold the Stein products alongside their own brand of refractories. It is possible, therefore, that the example from Cyfarthfa was associated with the acquisition of the works by GKN after 1909.

King Brothers, Stourbridge

King Brothers was a firm in existence between 1860 and 1955 based in Netherend in the West Midlands. According to contemporary advertising, the firm specialised in the manufacture of firebricks, glasshouse pots, crucibles, retorts and all fire-clay goods.

Their products have been found at the site of the Towcester Company Iron Works, which was in operation between 1875 and 1878, in association with iron smelting which suggests there was a precedent for the firm supplying specialist bricks to iron producers. As the Cyfarthfa coke works is the first archaeologically examined works of this nature, there are no references for comparison of the recovered bricks. However, two historical illustrations of various forms of refractory brick associated with the Coppée coke oven design are available, and some of the King Brothers bricks are similar to some of those illustrated. The majority of the bricks are likely to relate to the period 1882 to 1909.

J B Fisher and Company

JB Fisher & Co. owned the Hayes (Fireclay) Colliery in Stourbridge from the 1860s, and are listed as the Hays Fireclay Works in the 1872 to 1892 editions of the Kelly's directory for the area. The works had been taken over by Mobberly and Perry by 1896 and the stamps were changed on the bricks to reflect the new owners (Penmorfa). This would date the Fisher bricks from Cyfarthfa to the period between the late 1860s and early 1890s, which coincides with the period of modernisation and conversion to steel initiated by the Crawshay brothers. Though not many references of this manufacturer's bricks have been located, one example has been noted in Brazil.

Timmis Stourbridge

Timmis and Co. were started around 1871 near Lye, Stourbridge by GH and JA Timmis to mine fireclay from beneath the Stourbridge area. By 1881 they were sending out clay from their own siding connected to the Great Western Railway and presumably were making their own refractory products as well. The company existed until 1958 (Grace's Guide 2017). Timmis bricks have been found as far afield as Argentina although no significant references to their products have been located. No example of a Timmis stamped brick was noted in the assemblage, but one was noted within the construction of the south Coppée coke oven (flue 2526) and the manufacturer has been mentioned here as a result.

Welsh Brick Industries 1946

Welsh Brick Industries 1946 was formed in that year on the site of the former West End Brickworks Company (formerly Highland Park Brickworks) in Ely, Cardiff, and is listed in trade directories until 1968. Although the evidence is circumstantial, the close association of the 1946 date with the construction date of the Thorn lighting works suggests that the samples retained for examination may have been associated with the construction or maintenance of the lighting works.

NCB Tredegar

Although the Tredegar Iron Company had been established in 1800, operating a number of collieries in order to supply its works, the firm did not establish a dedicated

brickworks until 1933. Its products were stamped TIC (Tredegar Iron Company) and later simply Tredegar. On nationalisation of the company's collieries in 1946, the bricks were stamped NCB Tredegar (National Coal Board). The brickworks is believed to have closed in the 1960s. This suggests that the structures from which the NBC Tredegar bricks derive date between 1946 and the late 1960s. This coincides with the construction and operation of the Thorn Lighting works.

General conclusions

The majority of the specialist bricks employed in the initial construction of the Coppée coke ovens were most likely obtained from specialist manufacturers based around the Stourbridge area. It is probable that the expertise and materials for the construction of both the coke ovens and brickworks was bought in by the Crawshay Brothers with the intention to become self-sufficient at a later stage. These specialist materials were drawn from a relatively narrow group of suppliers who were used to meeting the needs of the iron and steel industries. It is perhaps stretching the evidence too far to suggest that they effectively supplied coke ovens in 'kit' form but the coding of brick patterns attests to a highly standardised production capability.

The absence of stamps on some specialist bricks in the assemblage suggests that Cyfarthfa may well have been manufacturing its own replacement products, as suggested by the contemporary works prospectus, although the evidence is circumstantial. Refractory bricks do, however, depend very much on the nature of the clay used in construction for the final properties of the bricks. It is unknown whether any of the local clays would have been suitable or whether suitable material would have been bought in from other concerns. Given that the prospectus states that the Cyfarthfa works were self-sufficient, however, it seems likely that material was locally sourced.

Relatively few constructional bricks were noted from the fabric of the coke ovens themselves; the standard sized bricks used were made from the same material used for refractory examples. The reason is obvious in that the oven area was likely to experience great heat and even construction work on the peripheries was carried out with heat resistant materials. The exception to this was the brick troughs for the hose system in the coke bench, and coal washery, for which red constructional material was used.

The bricks date in range from the 1870s to the mid-1940s. Bricks recovered from the fabric of the Thomas ovens are un-datable as they have no distinguishing features. The bulk of the assemblage derives from the period of the 1880s to 1919, conforming to the established date for the construction and operation of the coke works.

The later (mid-20th century) bricks are likely to be associated with the Thorn Lighting works.

Constructional bricks were generally unremarkable and are likely to have been locally sourced.

Given that there are very few sources of information concerning bricks of this period, it is impossible to state how the Cyfarthfa assemblage compared to those found on other sites. However, it is hoped that by taking a more detailed look at the brickwork, other sites excavated in the future may have reference to this material for comparison.

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Animal Bone Report – Hannah Bowden BA, MSc

During September to December 2013 excavations were conducted at Old Thorn Site, Cyfarthfa Ironworks, in which a total of twenty-two animal bone fragments (0.065kg) were hand collected from un-stratified deposits.

Methodology

The faunal remains were identified to species or species group with reference to known specimens and publications (Cohen and Serjeantson, 1996; Hillson, 1992; Schmid, 1972). The distinction between sheep and goat has not been made due to the relatively small size and condition of the assemblage. When species could not be identified, bone was categorized to species size, consisting of large mammal (domestic cattle or horse), medium mammal (domestic and wild ruminants and non-ruminates) and small mammal (domestic and wild carnivores, insectivores, lagomorphs and rodents). Ribs and vertebrae have been classed to species size only. Bone fragments were counted using the NISP methodology (Lyman, 2008).

The preservation and condition of bone has been observed using a scale of poor to good, detailed in Table 1.

Table 3 Scale of Fragmentation and Condition of bone

Scale	Fragmentation and Condition of bone
Poor	Fragments are small/unidentifiable. Only enamel/burnt fragments have survived. Surface of the bone is extremely pitted/cracked/various layers are notable.
Moderate	Fragmented/signs of modification (burnt/gnawed/butchered) with identifiable features. Surface of the bone is slightly pitted, with faint cracks/fairly intact.
Good	Complete element surviving/near complete element but slightly fragmented. The surface of the bone is in very good condition/smooth surface.

Results

The assemblage consisted of five sheep/goat bone fragments, one fragmented domestic fowl bone, two medium mammal sized vertebrae and long bone fragments with the remaining bone consisting of fourteen indeterminable fragments. The condition of the bone ranged from poor to moderate.

Due to the assemblage being derived from un-stratified deposits, no further work is needed and Table 2 contains a catalogue of the recovered bone. However, there is nothing unusual in the assemblage and the bone probably derived from later infilling of the site.

Table 4. Catalogue of animal bone recovered from Cyfarthfa Cokeworks

Context	Description	Quantity	Weight (Kg)
U/S	2 x sheep/goat phalanges 1 x medium mammal vertebrae fragment 1 x medium mammal limb bone fragment 14 x Indeterminable fragments	**18**	**0.035**
2000/U/S	1 x sheep/goat scapula fragment 1 x sheep/goat radius 1 x sheep/goat tarsal 1 x domestic fowl radius fragment	**4**	**0.030**

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Mortar analysis by Rob Dunning BSc MCIfA

Introduction

An initial assessment of the recovered mortar samples identified two main research questions. The first was to determine whether the mortar types change over time. This could be achieved comparing the samples from Phase 1 (1765-1840), specifically Bacon's Canal, with samples taken from Phase 2 (1840-1882), as well as from Phase 3 (1882-1926).

The second question was to determine if the mortar had been adapted to allow for thermodynamic expansion. With much of the ironworks dealing with both creating and managing high temperatures then these structures would need to withstand significant temperature change. It is possible that a higher quality refractory mortar would be used in structures close to high and fluctuating temperatures.

A total of 25 mortar samples were examined from and provided the dataset used for comparative analysis in order to address the two research questions noted above.

Comparison of samples from Phase 1 (1765-1840) with Phase 2 (1840-1882) and Phase 3 (1882-1926)

The two samples recovered from Phase 1, specifically Bacon's Canal (Samples 115 and 116), were compared to nine samples from Phase 2 (Samples 061, 078, 097, 103, 105, 107, 110, 112 and 114) and fourteen samples from Phase 3 (Samples 011, 015, 026, 028, 041, 046, 053, 055, 063, 069, 073, 080, 084 and 100). The samples were examined visually and described by colour and presence of inclusions. Hardness was tested by resistance to manual pressure:

Hardness	Description
Very hard	Impossible to break with manual pressure
Hard	Breaks with manual pressure
Soft	Breaks under light manual pressure
Very soft	Crumbles without additional pressure

Assessment

Sample	Context	Description
011	2052	Very hard grey mortar with frequent coarse components less than 2mm diameter (lime and coal)
015	2096	Very hard dark grey mortar with frequent coarse components less than 2mm diameter (lime)
026	2074	Hard dark grey mortar with moderate coarse components less than 4mm diameter (lime, coal and stone)
028	2098	Very hard grey mortar with isolated coarse components less than 2mm (lime and coal)
041	2281	Very hard orange-brown mortar with isolated coarse components less than 2mm diameter (lime). Clearly hardened and heat-affected.
046	2209	Hard light grey lime mortar with moderate coarse components less than 5mm (lime and coal)
051	2243	Hard light orange-brown clay mortar with isolated coarse components less than 2mm (stone)

053	2238	Very hard dark grey mortar with isolated coarse components less than 2mm diameter (lime)
055	2225	Soft light grey lime mortar with moderate coarse components less than 2mm (lime and coal)
061	2245	Very hard red-brown lime mortar with moderate coarse components less than 2mm (lime). Clearly hardened and heat-affected. Sample also contained fragment of iron slag (22mm in diameter)
063	2227	Very hard grey lime mortar with frequent coarse components less than 2mm (lime and coal)
069	2219	Very hard grey mortar with isolated coarse components less than 2mm in diameter (lime and coal)
072	2213	Very hard light grey lime mortar with isolated coarse components less than 2mm in diameter (lime and stone)
073	2224	Hard grey-black mortar lime mortar with isolated coarse components less than 12mm in diameter (lime and stone)
078	2278	Soft grey lime mortar with isolated coarse components less than 2mm in diameter (lime and coal)
080	2285	Soft yellow-white mortar with isolated coarse components less than 4mm (stone)
084	2284	Very hard orange mortar with isolated coarse components less than 2mm (coal). Clearly hardened and heat-affected.
097	2130	Soft white grey lime mortar with frequent coarse components less than 4mm in diameter (lime and coal)
098	2208	Very hard dark grey lime mortar with frequent coarse components less than 2mm in diameter (lime, stone and coal)
100	2212	Soft dark grey mortar with isolated coarse components
103	2365	Very hard red-brown mortar with moderate coarse components less than 2mm (stone). Clearly hardened and heat-affected.
105	2369	Hard yellow-white lime mortar with isolated coarse components less than 2mm in diameter (lime and stone). Clearly hardened and heat-affected.
107	2372	Soft dark grey lime mortar with frequent coarse components less than 4mm (lime, stone and coal). Clearly hardened and heat-affected.
110	2370	Soft grey-white lime mortar with isolated coarse components less than 2mm in diameter (lime and stone). Some fragments of the sample appear heat affected, others do not.
112	2364	Very hard red-brown lime mortar with moderate coarse components less than 2mm (stone). Clearly hardened and heat-affected.
114	2005	Soft grey lime mortar with frequent coarse components less than 6mm in diameter (lime, coal and stone)
115	2004	Soft light grey lime mortar with frequent coarse components less than 7mm (lime and coal)
116	2003	Soft dark grey lime mortar with moderate coarse components less than 5mm (lime, coal and stone)
125	2441	Hard dark grey clay mortar with isolated coarse components less than 2mm (coal)

The samples were crushed, dried and coarse aggregates larger than 2mm were removed. A 100g sub-sample was then dissolved in dilute hydrochloric acid (10%), following Cadw methodology (Cadw 2004, 2), dried and weighed to establish lime content. Overall composition of the mortar was calculated based on the coarse and fine

aggregates, combined with the soluble (lime) component. Dates were assigned based on the established chronology for Wales (Locock 2010).

Analysis

Prior to chemical analysis, a 100g sub-sample was taken and any coarse aggregates larger than 2mm were removed. These were angular and sub-angular stones and coal fragments. The remaining fine aggregate and lime sample was utilised to establish lime content. Two samples weighed less than 100g in their entirety (Samples 011 and 026), therefore the whole sample was utilised to establish lime content in these cases.

Sample	Coarse aggregate (g)	Fine aggregate and lime (g)	Total (g)
011	-	85.1	85.1
015	-	100	100
026	8.9	87.2	96.1
028	-	100	100
041	-	100	100
046	14.9	85.1	100
053	-	100	100
055	-	100	100
061	-	100	100
063	-	100	100
069	-	100	100
073	20.9	79.1	100
078	-	100	100
080	8.4	91.6	100
084	-	100	100
097	12.4	87.6	100
100	11.7	88.3	100
103	-	100	100
105	-	100	100
107	9.1	90.9	100
110	-	100	100
112	-	100	100
114	18.0	82.0	100
115	15.1	84.9	100
116	25.1	74.9	100

The mortar was then dissolved in dilute hydrochloric acid (10%) in order to establish lime content.

Sample	Fine aggregate (g)	Lime (g)	Total (g)
011	84.6	0.5	85.1
015	88.7	11.3	100
026	48.5	38.7	87.2
028	98.3	1.7	100
041	100	-	100
046	65.8	19.3	85.1
053	91.9	8.1	100
055	78.2	21.8	100
061	99.7	0.3	100
063	98.3	1.7	100
069	99.2	0.8	100
072	99.2	0.8	100
073	35.8	43.3	79.1
078	70.2	29.8	100
080	55.8	35.8	91.6
084	99.8	0.2	100
097	62.6	25.0	87.6
100	53.9	34.4	88.3
103	99.5	0.5	100
105	98.0	2.0	100
107	32.3	58.6	90.9
110	87.8	12.2	100
112	98.9	1.1	100
114	43.2	38.8	82.0
115	42.4	42.5	84.9
116	51.6	23.3	74.9

Results

Samples from Phase 1 (1765-1840)

Sample	Coarse aggregate %	Fine aggregate %	Lime %	Total
115	15	42	43	100
116	25	52	23	100
AVERAGE	**20**	**47**	**33**	**100**

Samples from Phase 2 (1840-1882)

Sample	Coarse aggregate %	Fine aggregate %	Lime %	Total
061	-	100	-	100
078	-	70	30	100
097	12	63	25	100
103	-	99	1	100
105	-	98	2	100
107	9	32	59	100
110	-	88	12	100
112	-	99	1	100
114	18	43	39	100
AVERAGE	**4**	**77**	**19**	**100**

Samples from Phase 3 (1882-1926)

Sample	Coarse aggregate %	Fine aggregate %	Lime %	Total
011	-	99	1	100
015	-	89	11	100
026	9	51	40	100
028	-	98	2	100
041	-	100	-	100
046	15	66	19	100
053	-	92	8	100
055	-	78	22	100
063	-	98	2	100
069	-	99	1	100
073	21	36	43	100
080	8	56	36	100
084	-	100	-	100
100	12	54	34	100
AVERAGE	**4**	**80**	**16**	**100**

Comparison of samples from structures managing high temperatures and samples from structures managing low temperatures

Seven samples (041, 061, 103, 105, 107, 110 and 112) were postulated to manage high temperatures, originated from Thomas Ovens. These were compared to eighteen samples (011, 015, 026, 028, 046, 053, 055, 063, 069, 073, 078, 080, 084, 097, 100, 114, 115 and 116) from low temperature structures, such as the Canal, Sheppard Washer etc.

Results

Samples from high temperature structures

Sample	Coarse aggregate %	Fine aggregate %	Lime %	Total
041	-	100	-	100
061	-	100	-	100
103	-	99	1	100
105	-	98	2	100
107	9	32	59	100
110	-	88	12	100
112	-	99	1	100
AVERAGE	**1**	**88**	**11**	**100**

Samples from low temperature structures

Sample	Coarse aggregate %	Fine aggregate %	Lime %	Total
011	-	99	1	100
015	-	89	11	100
026	9	51	40	100
028	-	98	2	100
046	15	66	19	100
053	-	92	8	100
055	-	78	22	100
063	-	98	2	100

069	-	99	1	100
073	21	36	43	100
078	-	70	30	100
080	8	56	36	100
084	-	100	-	100
097	12	63	25	100
100	12	54	34	100
114	18	43	39	100
115	15	42	43	100
116	25	52	23	100
AVERAGE	**8**	**71**	**21**	**100**

Discussion

The samples taken from Phase 1 (1765-1840) have an average lime content of 33%, with such composition typical of the late 18th century, containing pure lime lumps and coal fragments, and perhaps reflect an informal formula of one part lime to two parts coarse/fine aggregate.

The samples from both Phase 2 (1840-1882) and Phase 3 (1882-1926) have markedly lower lime contents, averaging 19% and 16% respectively. This is unusual, with later mortars (particularly those dating to the 20th century) generally having significantly higher percentages of lime. It is likely this is partly due to several of the samples from Phase 2 at least exhibiting evidence of being subject to severe heating (061, 103, 105, 107, 110 and 112) which with the exception of sample 107 has potentially led to the thermal decomposition of the lime content of the mortar. The remaining samples from Phase 2 which do not exhibit obvious evidence of severe heating have an average lime content of 31%. However, all of the samples from Phase 3 were recovered from low temperature structures and so the anomaly of such minimal lime content cannot be explained by thermal decomposition.

It would appear that the generalisation of increased lime content indicating a later date range does not appear to apply to the Cyfarthfa structures. This is particularly of note as such date ranges, which are generally applicable across South Wales, have previously been applicable to the Merthyr area. Indeed previous analysis of mortar samples recovered from the analogous ironworks at Ynys Fach indicated a much higher lime content for samples from the later structures (58% on average).

Comparison of the mortars from high and low temperature buildings were also not particularly informative. The samples showed few physical differences, with material from high and low temperature structures containing both hard and soft mortars. Conversely the coarse/fine/lime ratios were disparate, with no consistency between the high and low temperature samples. Indeed the average lime content of the samples from the high temperature structures were broadly similar to the average lime content of the samples from the low temperature structures (11% and 21% respectively).

However, it remains the case that potentially some adaptation to allow for thermodynamic expansion was utilised in order to preserve the structure of the mortar. The results of the analysis suggest that any such changes are not apparent in the physical appearance, or the coarse/fine/lime ratio. It is possible that a refractory mortar was used in areas subject to high temperatures, with substances such as aluminium, silicon or magnesium oxides, or perhaps more likely, a high quality fire clay, used to increase the

refractory properties of the mortar, with any such additions not being apparent utilising the current methodology.

Refractory mortar was used to present a continuous, single-face to the high temperatures found in the furnaces for example, sealing gaps between firebricks on the interior elevation of the structure. A refractory mortar's purpose was not to bind the component stones or bricks together. It is possible that the refractory mortar 'skin' did not survive and that the samples were taken from the binding mortar located in the body of the structure itself, mortar that would not have required as significant adaptation to thermodynamic expansion, hence the similarity in the results.

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Clay pipes - Charlotte James (GGAT)

A total of 31 fragments of clay pipe were recovered and reported on from excavations carried out at the Old Thorn Site, Cyfarthfa. The larger part of the assemblage was un-stratified but included a number of interesting stamped pieces with a number of different maker's marks.

Table 5. Catalogue of clay pipe fragments

Context	Description	Quantity
2000	• Two unmarked undiagnostic fragment of pipe stems. • One fragment of pipe stem with fluting • One stem and spur fragment with an almost illegible maker's mark possibly W/P relief on either side of the spur. If it does read W/P it is most likely manufactured by William Pardoe or from his factory at Nantgarw 1833-60. A small amount of bowl remains with a leaf design on the front mould line.	4
2002	• An unmarked undiagnostic fragment of pipe stem.	1
2332	• One unmarked undiagnostic fragment of pipe stem with a missing spur.	1
U/S	• Eleven unmarked undiagnostic fragments of pipe stem. • Three unmarked stems with mouthpieces, one green glazed • One partial 'RAOB' bowl with the buffalo horn motif, a common 19th century design. These pipe usually date between 1850 and 1930 however some are still made today for The Royal Antediluvian Order of Buffalo possibly for use in the initiation ceremonies. • One plain bowl with small spur, probably 19th century. • One badly made bowl fragment with 19th century leaf pattern • One fragment of 19th century leaf pattern bowl • One fragment of bowl with 19th century fluted pattern. • One fragment of stem with W.SOUTHORN/BROSELEY, Pipe of William Southorn of Broseley, 19th Century. • One stem fragment with small spur stamped with K or H /P. There were numerous makers with the initials HP working locally, including at least four in Nantgarw in the 19th century. • One stem fragment with PARDOE/NANTGARW stamp. Possibly made by William Pardoe, but is most likely late in date and may belong to Percival Pardoe working from the same Nantgarw factory in the late 19th century into the early 20th. • One stem fragment with C.PRIEST/CANTON stamp. George Priest was a pipe maker in Canton from 1863 and died in 1907 and was also known as a local publican. • One stem fragment with leaf pattern and small spur • One partial plain bowl with small spur with a flattened end.	25

Discussion

There were a number of maker's marks and diagnostic fragments in the assemblage mostly dating the collection from the middle to the late nineteenth century, however few were recovered from stratified contexts. The pieces identified in the stratified contexts (2002 and 2332) were undiagnostic and unmarked.

There is nothing unusual in the assemblage, which dates to the operational period of the works. If anything, the relative dearth of fragments suggests that the activity of smoking may have been controlled within the areas of the works that were excavated.

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9 Discussion

Cyfarthfa Ironworks is one of the most important industrial heritage sites in the world. The extensive remains of the blast furnaces, along with remains of engine houses, melting houses and the infrastructure related to the works, have rightly been recognised as being of international significance and therefore accorded statutory designation as Scheduled Ancient Monuments. The provision of coke to the works was integral to the operation of the ironworks from its earliest days, and the extensive remains uncovered during archaeological work described above revealed evidence for coke production from every phase of its 150-year lifespan but most substantially in the remains of the Coppée coke works was constructed in 1882. The merits, or otherwise, of divorcing individual elements of the formerly coherent Cyfarthfa estate are beyond the scope of this current report.

Phase 1 - 1765-1840, (Figure 19)

Perhaps the most surprising discovery resulting from the archaeological work undertaken as part of the redevelopment of the site, was part of Anthony Bacon's canal which had supplied the coke yard; no specific dating evidence was found but there can be little doubt that the feature is Bacon's canal and dates to at least 1777, if not slightly earlier. Although the canal was known from historical sources, these are somewhat vague and add little of substance to the understanding of how the Cyfarthfa site operated in the late 18th century. The canal was certainly out of use by the late 1840s, although the construction of the refractory brick culvert within the actual channel of the canal suggests that it still had an active part to play in the later operation of the works through the provision or management of water to the coke yard site. The very course of the canal had been lost until its re-discovery as part of the archaeological work and comparison of the remains with the estate map of 1795 suggests that more of the canal and associated early buildings may lie buried beneath the ground. Recording of the canal's form and dimensions has allowed a basic comparison with other, contemporary industrial canals in Shropshire, a process which suggests that they were similar in nature.

The remains of Anthony Bacon's canal are important in terms of their heritage value. Part of the canal has been recorded south of the development area (NPRN 232778) but this information dates to 1978 and is based primarily upon documentary and cartographic evidence. The section exposed during the archaeological work provided the only substantial information as to how it was actually used, together with its appearance, dimensions and structural data. As the remains were re-buried, they have been preserved for future generations.

Other ephemeral remains from this early period were located in the form of isolated walls, tram-road tracks and drains. Accurate dating of these features has proved impossible due to the absence of datable material but the phasing evidence suggests that

they are likely to date to the first few decades of Cyfarthfa's existence, with sleeper group 2296 for the tram road certainly predating 1856. This evidence has allowed the compilation of a basic map of Phase 1 remains (Figure 19) and demonstrates just how much was lost through later redevelopment of the works. This phase saw Cyfarthfa arguably at the peak of its technological innovation and expansion, at a time when Cyfarthfa was becoming the largest iron works in the world, with the adoption of a modified form of Henry Cort's puddling furnaces and the introduction of grooved rollers for producing bar iron. This is also the period of operation of the works depicted in the illustration of the site by William Pamplin, who showed the coke yard in operation (Plate 140). Although there is no obvious sign of the canal, coking in heaps is depicted, together with a number of ancillary features such as a horse or mule drawn tramway, several buildings and a crane like apparatus.

Plate 140. Close-up photograph of the coke yard drawn around 1798 by William Pamplin. Although some artistic licence may be expected, this depicts the coke yard as it would have looked in Phase 1. Curiously, no canal is depicted, although it was certainly in existence at the time. (Author's collection).

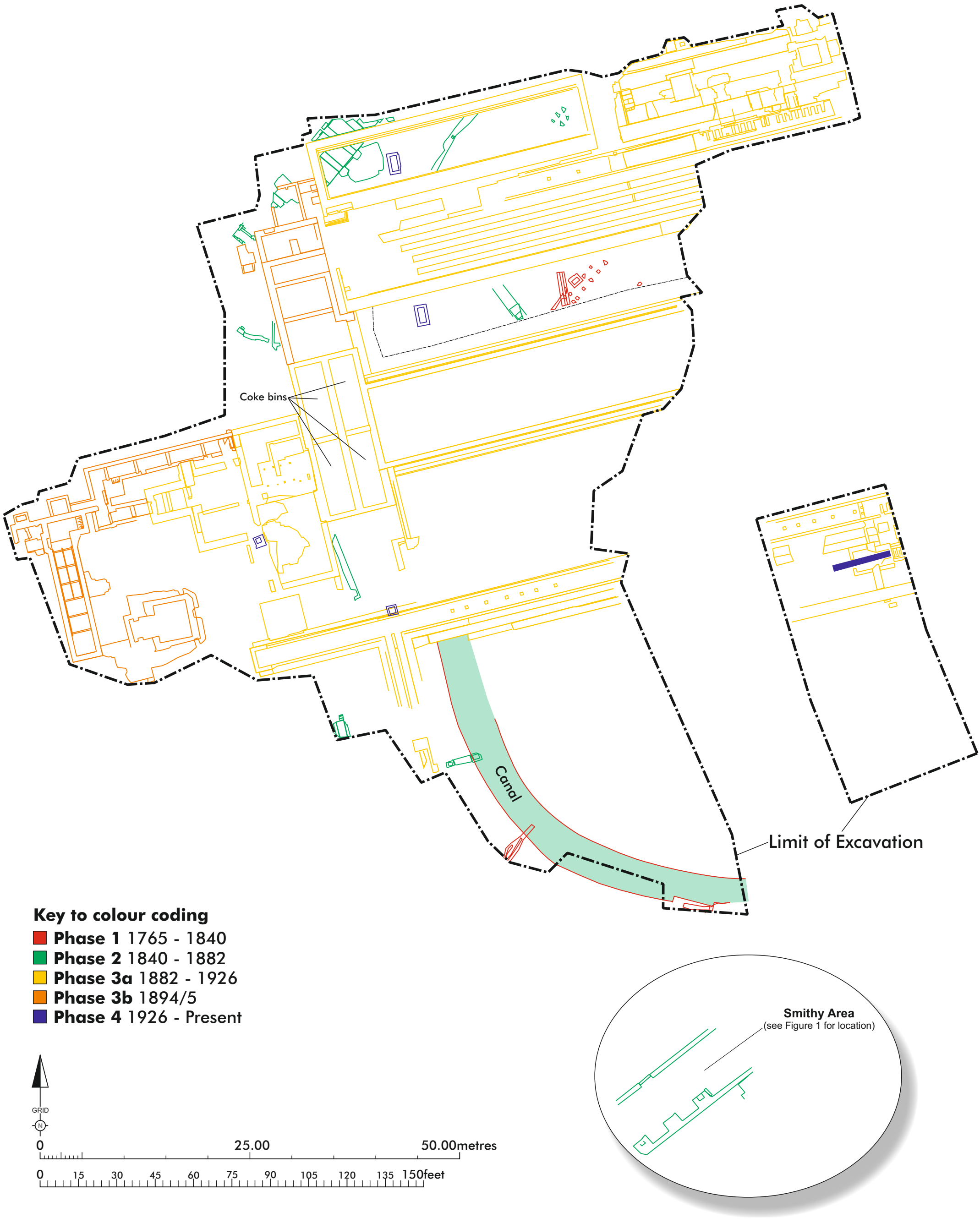

Figure 19. Phasing plan for the Cyfarthfa Coke works features dating from approximately 1765 to present.

Phase 2 – 1840-1882 (Figure 19)

Phase 2 encompassed a period of continued prosperity and stagnation in the fortunes of the Cyfarthfa works. This can be seen in the archaeological remains as investment in new coking technology in the form of the Thomas ovens although the earlier method of coking in heaps appears to have been retained. These developments would almost certainly have been known about, particularly given the initial close relationship between the Cyfarthfa and Plymouth iron works, one of whose owners was a key driver in the refinement of the technology of coking in heaps. Curiously, no structural evidence for these developments was found, although much of coke yard of this period had been destroyed by construction of the later Coppée ovens. Neither was there evidence for the presence of beehive ovens, although the same caveat applies. The canal may have been adapted as a water source, possibly to aid in the supply of the huge quantities of water required for dousing the coke, although there is no evidence for how this water was extracted, and it is more plausible that the canal was covered and channelled simply to remove it as an obstacle which divided the coke yard; certainly, it is clear that tramways or narrow gauge industrial railway became the main means of transportation within the site, once the canal had been buried. A prominent water outlet depicted on OS mapping and known as the Trant bach, may have been the main drain for the canal although there is no easy way of proving this as the direction taken by the underground passages is unknown. The outflow channel is still extant, outside the development area boundary, and a cursory examination suggests that the culvert containing the water branches, indicating several sources of water had been channelled. Water continues to flow out to this day and the development appears to have had little discernible effect on this flow.

The Thomas ovens can be dated fairly accurately through cartographic evidence to between 1851 and 1856 (Plates 141 and 142). It is possible that the decision not to completely abandon the method of coking in heaps and to retain that method in tandem with the Thomas ovens may have been the first sign of the technological conservatism that appears to have bedevilled the Cyfarthfa works from the 1850s onwards. Even after construction of the Coppée ovens in 1882, one a set of Thomas ovens appears to have been retained, possibly as a redundancy measure but also indicating a failure to fully trust the new technology.

One factor which may have played a part in the gradual conservatism evident in the Cyfarthfa operation is the financial cost of building and maintaining not one (Cyfarthfa Castle in 1824) but two grand houses. The Crawshays had acquired Caversham Park in Oxfordshire in 1838 but when the original building was destroyed by fire in 1850, William Crawshay II had an impressive new building erected, the current Caversham Park. The financial strain of these two properties may have made the Crawshays more reluctant to invest in new technology and to become reliant on the steady returns guaranteed by their existing operation. Certainly, family politics played a significant

part in the various levels of involvement in the actual day to day running of the Crawshay concerns (Parry pers. Comm. 2017) and is quite possible that this perceived conservatism was a symptom of such politics. It is possible that more research might shed light on this aspect of the Cyfarthfa story.

Despite the partial survival, the remains of the Thomas ovens themselves are of significance, as they are, as far as the author can ascertain, the only archaeologically examined examples of this transitional technology. The recorded dimensions do not quite match with those referenced by John Percy but they are almost certainly the ones he saw when he visited the works in the 1850s and 1860s. Whether the shorter oven length represents an earlier iteration of the technology or whether it is simply a convenient local standard is unknown as there are no other known examples for comparison. The constructional techniques employed *e.g.* the use of red brick for the flooring, generally match Percy's description. However, as Percy stated that the Cyfarthfa ovens had been in use for many years, it is probable that they were an early example of their type. The remains of the Thomas ovens recorded at Cyfarthfa are likely to constitute the only record of this type of feature for many years; they were re-buried and have been preserved *in situ* although it should be noted that similar, associated remains almost certainly survive beneath the ground, outside the boundary of the development area.

Although thoroughly demolished in the 1920s, the smithy building represented an element of continuity between phases and is testament to the vital work of blacksmiths in the day to day operation of iron works. The layout of the building is likely to have remained unchanged throughout its lifetime but little else can be said about the structure. The little that remained of the smithy was re-buried for preservation *in situ*. And the features relating to Phase 2 have been included on a plan for ease of reference.

Plate 141. Extract from the 1851 Merthyr Board of Health map showing the coke yard area (development area is outlined). No coke ovens are depicted and coking in heaps is almost certainly the technology employed. This is likely to be similar to the coke yard layout depicted by Pamplin in 1798.

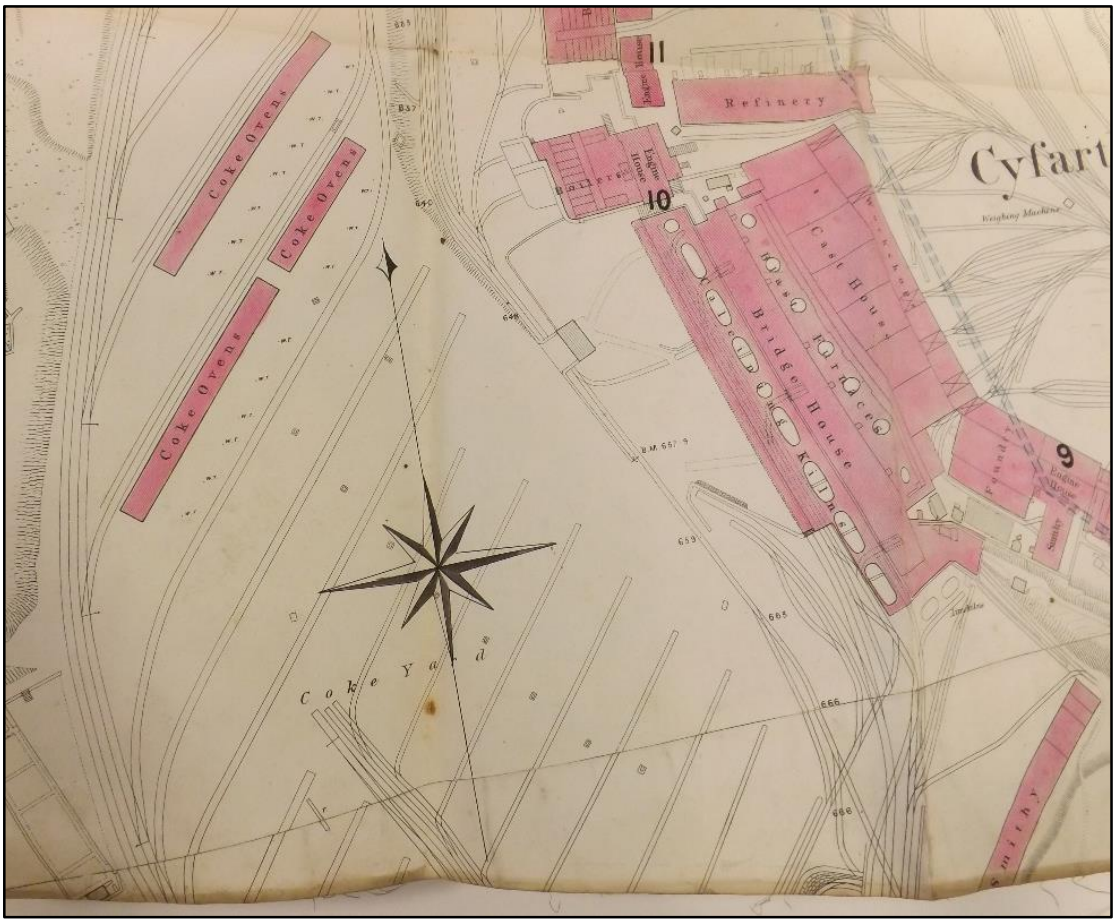

Plate 142. The coke yard depicted in 1856 by Mr Cope Pearce. The Thomas ovens have been constructed, indicating a construction date of between 1851 and 1856. (Glamorgan Archives DG/F/9/10)

Phase 3 – 1882-1926 (Figure 19)

The majority of the recorded remains derive from Phase 3 and constitute the belated attempts at modernisation of Cyfarthfa undertaken by the Crawshay Brothers after the death of Robert Thompson Crawshay in 1879. The conversion from iron to steel making by the construction of Bessemer converters came almost a quarter of a century after their great rivals at the Dowlais ironworks. The reasons for this delay in adopting steel production are rather obscure and possibly owe much to internal family politics but it is clear that the Crawshay family had become conservative in their outlook with regard to the Cyfarthfa works. It is highly likely that the decision to convert the works was the spur for the construction of the Coppée ovens at Cyfarthfa in 1882. They were built over the demolished remains of the previous coke yard and together with the Bessemer converters and brickworks, represented a considerable investment into the business.

The design of the Cyfarthfa Coppée ovens, as noted by Jackson, is unique. The reasons for this are unclear but it is possible that the topography of the site lent itself to two parallel batteries of ovens rather than the more conventional single row. Also apparently unique is the arrangement of the central storage bunker, which again, may have been the result of the nature of the ground. A basic coal washery with attendant Carr's disintegrator was always intended to be part of the design (Phase 3a) but was supplanted a decade or so after initial construction by the installation of the Sheppard Feldspar washery (Phase 3b, and note the differences between Plates 143 and 144). It is probable that the Sheppard washery was simply more efficient but the stipulation that the Carr's disintegrator was to be retained for emergency use is interesting. The recorded remains indicate that some modification of the original structure was required to accommodate the Sheppard equipment and could be seen as simply an attempt to build redundancy into the operation. However, it is also perhaps yet another sign of the failure of the Crawshays to whole heartedly trust in new technology, despite the apparent advantages.

The construction of the Coppée ovens is likely to have been carried out by an outside contractor, using materials sourced from the West Midlands. With the completion of the Cyfarthfa brickworks, the business would have been self-sufficient in the provision of refractory and constructional brick. It is curious, however, that whilst Cyfarthfa stamped brick is attested from other parts of Wales, not a single example of a brick bearing the Cyfarthfa stamp was noted.

Plate 143. Plan of the Cyfarthfa Coppée coke oven dated 23rd February 1892. This is the form of complex prior to construction of the Sheppard washery in 1894/5. The red squares indicate the location of steam engines (Glamorgan Archives DG/F/9/10).

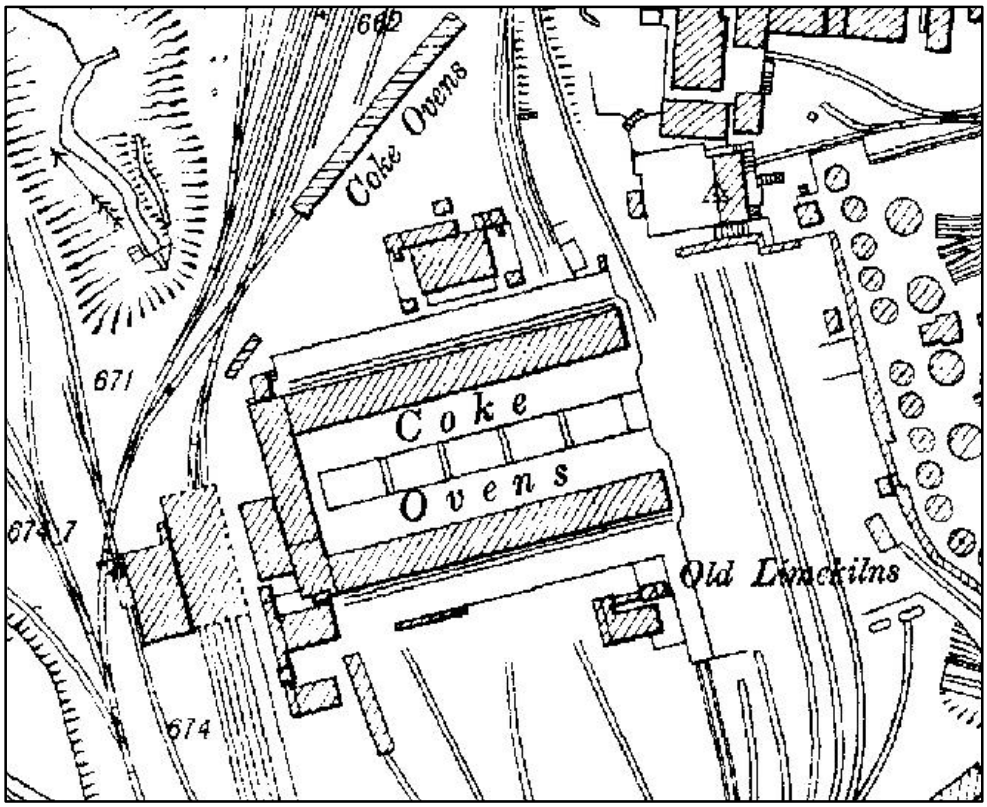

Plate 144. Second edition OS map of 1904 showing the Coppée coke oven complex. This is the form of the ovens following the construction of the Sheppard Washery in 1894/5.

As in the example of the Thomas ovens, there are no other previously investigated Coppée ovens with which to compare with the Cyfarthfa remains and the results must stand on their own merits. The different features broadly conform to the theoretical plans of Coppée ovens contained within a copy of the Proceedings of the North of England Mining and Mechanical Engineers Institute of 1872/73 (Appendix III) although only the very base of the oven structures on the north side had survived. Sufficient had survived to allow the identification of the main gas flue and the front retaining wall for the coke ovens. The specialist refractory bricks from which the ovens and associated flues had been made had been left behind as being of little value to the demolition firm in the 1920s. Whereas standard sized bricks could easily be re-used (see the contemporary newspaper quote stating that millions had been taken for use in Cardiff) the highly irregular shapes and sizes of the coke oven bricks prevented their use for anything else.

The remains of the down-takes for diverting the main gas flue contents around the unexcavated north boiler complex was something not depicted on the plans with any great detail. The excavated remains presented something of a puzzle in terms of the phasing but it is clear that this area underwent significant re-modelling in terms of the blocking of secondary flues. It is unclear why this was carried out; it is possible that a new boiler system was introduced or that damage from heat may have necessitated a change in layout. Another possibility considered was the re-use of the Cyfarthfa works during the First World War. Following its closure in 1910, no activity was carried out on site, although some sources suggests that the coke ovens were kept operating by GKN. An inspection of the works by representatives of the Ministry of Munitions in 1916 discovered rabbits living in an engine house (Glamorgan Archives DG/C/1/24). However, Number 3 furnace was put back into blast on 23rd October 1917 for the processing of pig iron into shell steel and this would have required quantities of coke. The most obvious source of this fuel would have been from Cyfarthfa's own ovens and it is possible that the re-modelling may have taken place in order to accommodate this late activity after a prolonged period of dormancy.

The Coppée ovens and attendant washery owe nothing to the previous layout of the coke yard. Despite being an older form of technology (the Coppée principle was almost 30 years old at the time of construction at Cyfarthfa) there was a clear attempt at breaking with the past with a completely different set of alignments, to create a state of the art-facility. This can be easily appreciated from the Phase 3 (Figure 19) plan of the site. The irony is that coke ovens based on the Coppée principle were on the verge of becoming obsolete in 1882. By the latter part of the 19th century, non-recovery coke ovens *i.e.* those in which waste gasses were burnt off, were being replaced by those that were able to refine chemical elements within the waste gasses to produce a range of useful products. This resulted in a more economically sustainable and probably unintentionally, cleaner system. The Cyfarthfa Coppée ovens represent, yet again, the

failure of the Crawshays in the latter part of their ownership to truly adapt to technological innovation.

The final discussion point must be the discrepancies apparent in the surveyed extent of the Coppée ovens as depicted on contemporary mapping, and the actual physical remains that were excavated.

Even allowing for the fact that the majority of the physical remains of the Coppée ovens had been destroyed by the construction of the Thorn Lighting Works, there is a marked asymmetry in the archaeological remains of the south coke battery which is not apparent on the mapping. The main gas flue for the south battery extends well to the west, beyond that of the north battery, as well as possessing a spur to the south, a feature that does not appear to exist for the north battery. The presence of this flue may well be explained by the presence of two chimneys south of the coal crusher, washery on the photograph of the works dating to the early 1890s. The north coke oven battery was equipped with down takes to re-use heat for heating a boiler plant; no such requirement existed for the south battery, and it is likely that the extension and spur represent the efforts to channel waste gas straight into conventional chimneys.

Whilst this is the likely explanation, the OS mapping is not sufficiently distinct to be definitive. It should also be remembered that the ground levels had been reduced to such an extent that everything that was exposed had originally been buried. This means that surface features may have had a different layout and appearance when surveyed underground; the asymmetry of layout is only apparent in the excavated archaeological remains.

Phase 4 - 1926-present (Figure 19)

The demolition of the Cyfarthfa works as a whole was particularly thorough and this is certainly true for the coke works site. The actual contract for the demolition work survives in the Glamorgan Archives indicating that the demolition was to have taken place between 13th September 1924 and 13th March 1926. The major structural elements had been removed by this date and all the loose material *i.e.* salvageable material such as masonry, brick and metal, had been removed from the site, although some of the material was used to level the ground where holes existed. The majority of the relatively small artefactual assemblage of pottery and glass recovered from the site dates to this period. Photographs of the site taken prior to the construction of the Thorn Lighting works in 1947 show a flat area, containing no recognisable structures. Construction of the lighting works truncated large parts of the former coke works, in particular the south coke oven battery and ancillary buildings. However, as has been seen, significant areas remained beneath the ground, and it is highly likely that other areas of the works remain buried outside the development area. This includes the remains of the north boiler complex and probably the remains of the Cyfarthfa brickworks to the north west.

The Thorn Lighting works was, in its turn, thoroughly demolished in 1993. Combined with ground preparation in advance of the current development, only the lowest elements of the Thorn lighting works, such as drainage features, and datable through the brickwork, had survived. However, the re-use of elements of the coke works in the designs for the Thorn Lighting works, specifically the re-use of the south coke oven battery main gas flue as a pipe run suggests that there was a good awareness of the original layout of the coke works when the lighting works was built. The very little that survived from this period is indicated on the Phase 4 plan (Figure 19) but the demolition was so complete, that little more can be said on the use of the site during this period.

10 Conclusion

The redevelopment of the site of the former Cyfarthfa coke works afforded a hitherto unique insight into the production of coke at an ironworks of major importance, across the span of its existence. The recorded remains will serve as useful reference for future research and helps to form another component of the story of the Cyfarthfa Ironworks. The work has recorded the remains of a Coppée coke oven in unprecedented detail and in archaeological terms, forms the most thorough dataset for this site type that currently exists. The research carried out for the current report has also highlighted some potential discrepancies with the accepted version of the development of Cyfarthfa which will require more investigation.

The physical remains encountered at Cyfarthfa are largely devoid of the human element; very little in the form of personal effects was discovered possibly due to a combination of the level of truncation but also to the impersonal nature of working environments at that time. The closest connection to individuals, and in particular to Anthony Bacon and the Crawshays, has been in the form of the structures themselves. It was these individuals, by turns dynamic and innovative, at others rather conservative in outlook, who were responsible for the development of the site, and it is their legacy that was excavated and examined within the development area.

The work has demonstrated that extensive remains relating to the Cyfarthfa ironworks as a whole are likely to survive outside the current development area and this may have an impact on the planning of future developments in the area. The Phase 1 and 2 period remains were recorded and re-buried, being preserved *in situ*. Following recording, much of the exposed Phase 3 remains were demolished but significant elements of the north coke oven battery flue system and the central storage area remain *in situ*.

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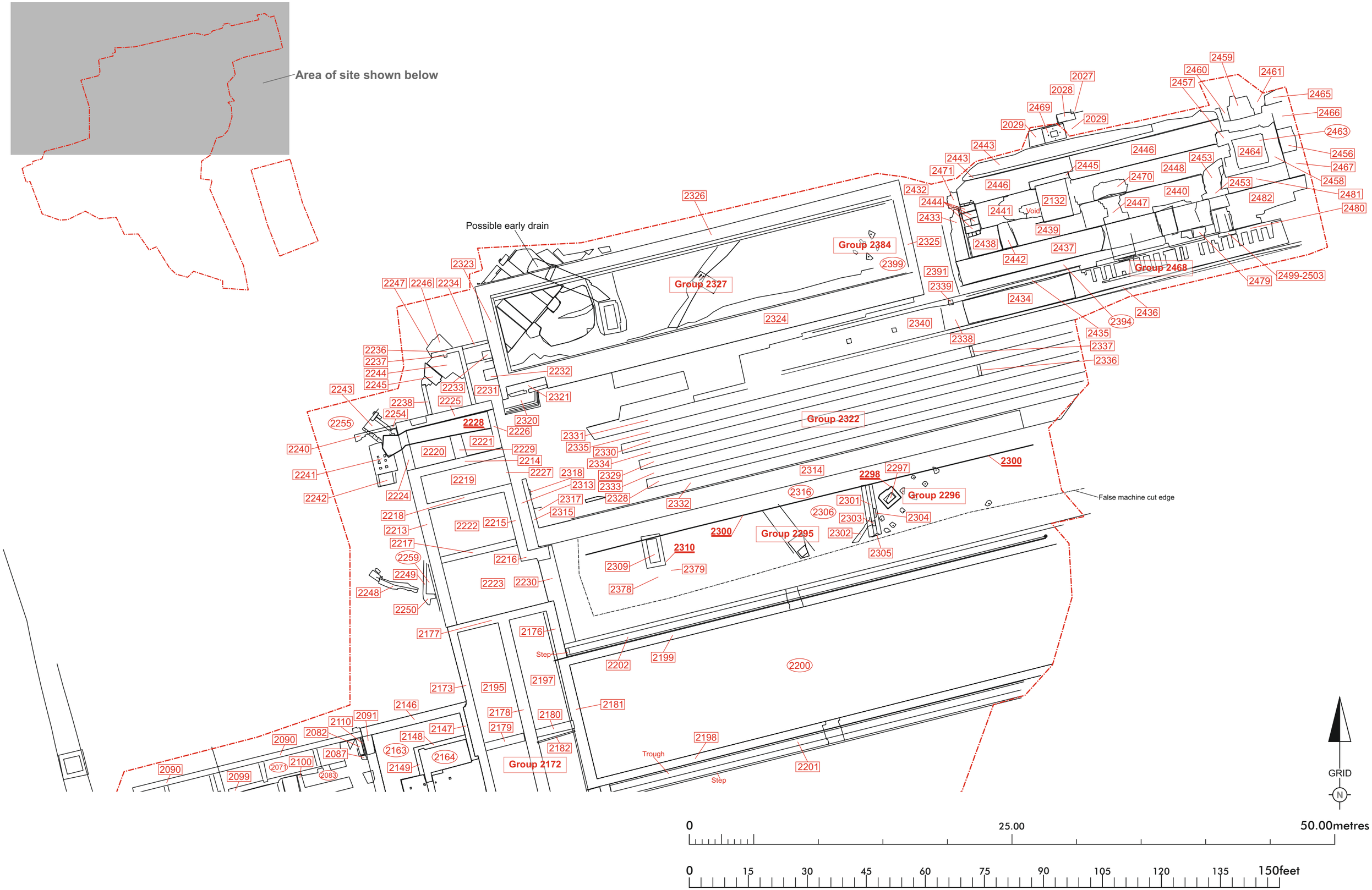


Figure 20. The northern area of the site showing extent of surveyed remains (black), structure numbers (red-box), context numbers (red-ellipse), group numbers (red-box bold) and cut numbers (red-bold underlined).

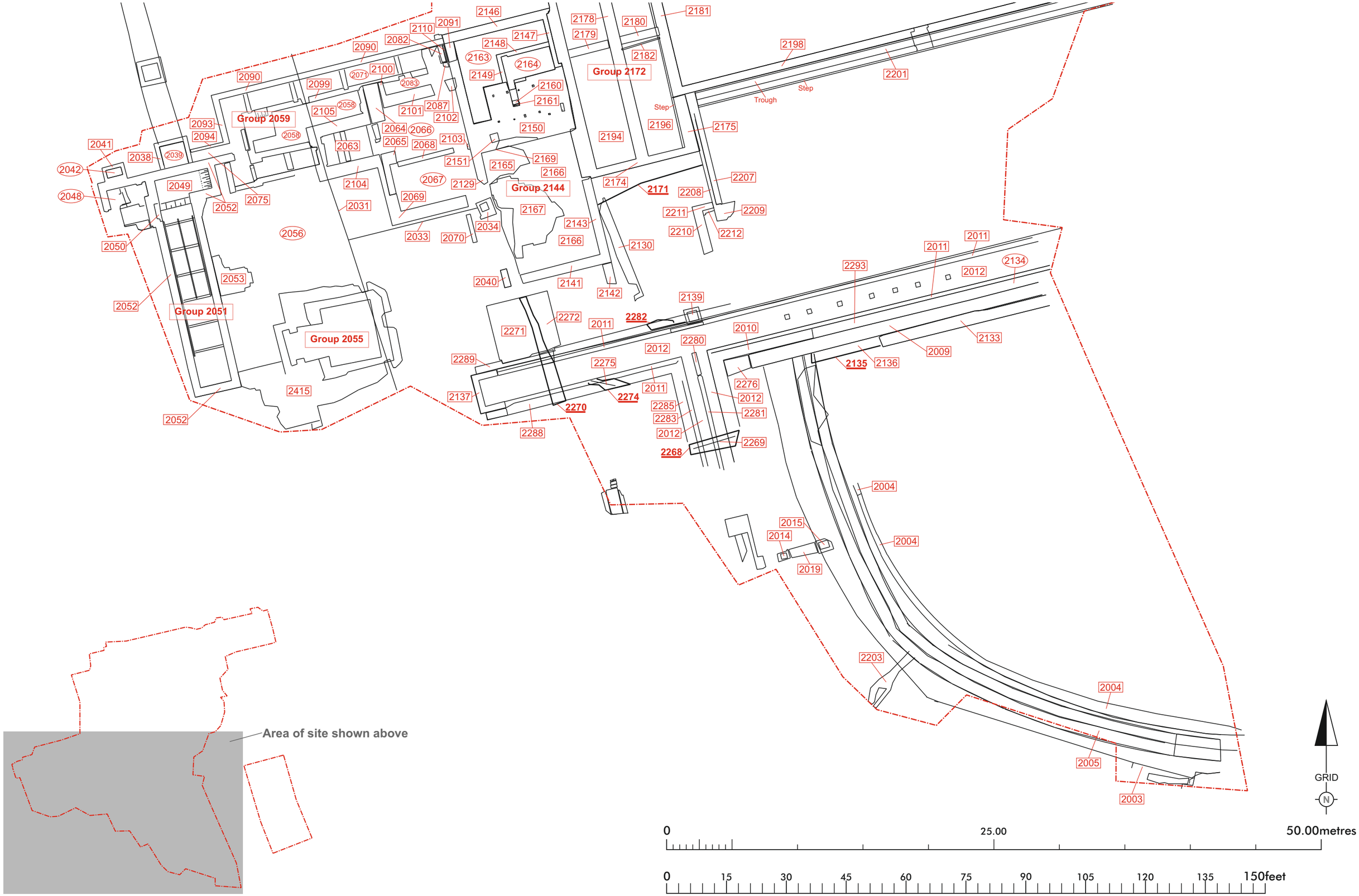


Figure 21. The southern area of the site showing extent of surveyed remains (black), structure numbers (red-box), context numbers (red-ellipse), group numbers (red-box bold) and cut numbers (red-bold underlined).

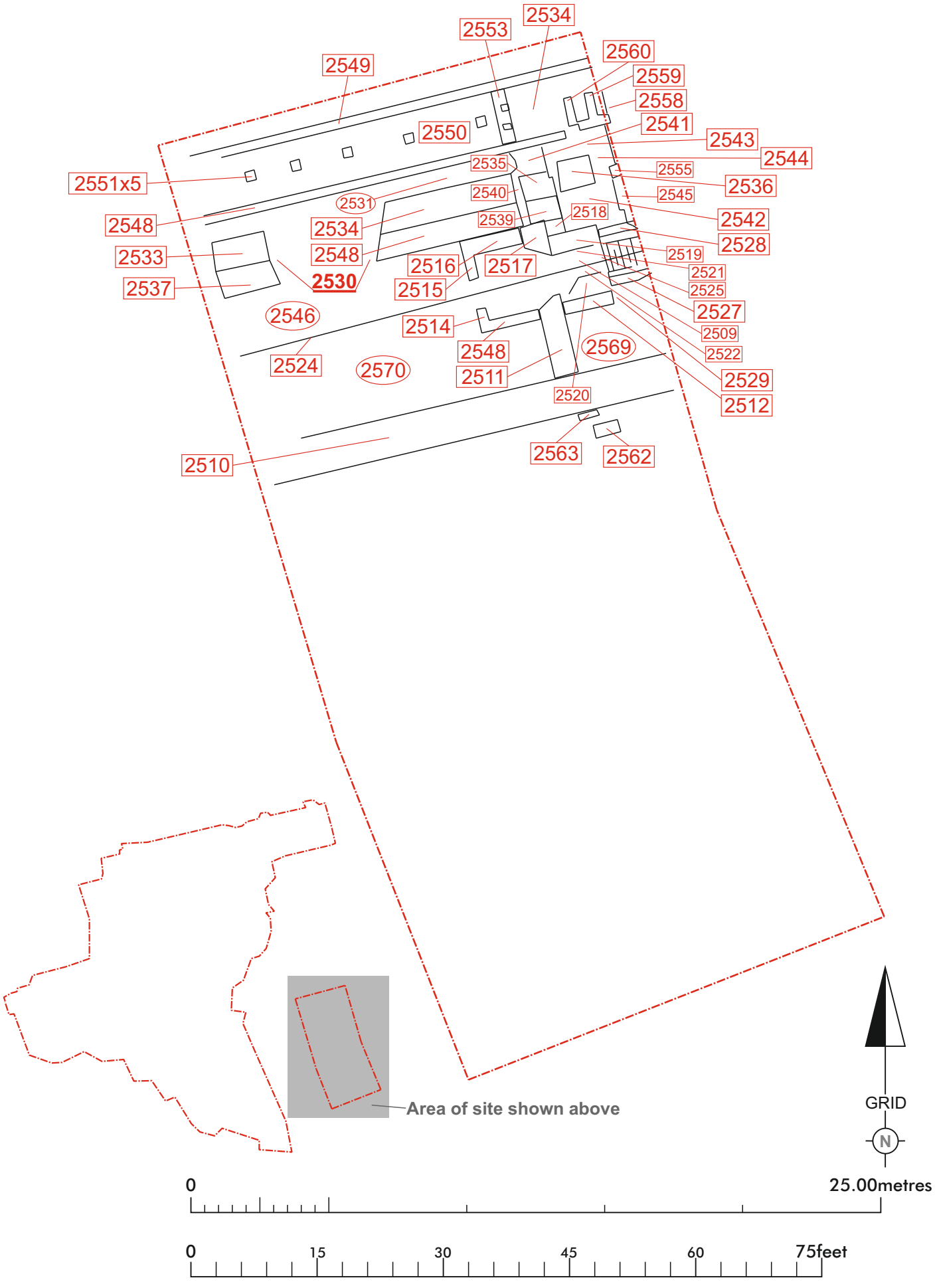


Figure 22. The eastern area of the site showing extent of surveyed remains (black), structure numbers (red-box), context numbers (red-ellipse), group numbers (red-box bold) and cut numbers (red-bold).

Appendix I Inventory of contexts

The following table contains the transcribed site context records. Blank spaces denote where the information was absent or unclear on the original sheets.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2000	Deposit	Fill over site general	Covers site.	0-2m	A black/grey deposit. The general fill over the site. Contains some black/brown silts industrial deposits *i.e*. slag and coal ashes. Some clays mixed in some areas from deposits being moved around by plant and machines. Similar to those seen in the field evaluation. Report 2012/030. There is a general fill of modern material overlying coal and coal dust deposits that built up during the crushing up of the coke yard and tramways bringing the coal for coking (underlies 2000). There may well be different coal deposits that are not entirely clear.
2001	Negative feature	Canal Cut			Construction cut either side of walls 2003/2004. Would appear to be tight to rear buried elevations of walls. Walls constructed of rough rubble and lime mortar infill between cut and quality stone skin. Only seen in plan.
2002	Structure	Stone Capping	6.2mL x 3m W	40-60mm	Layer of capping over stone capping over stone culvert. Sandstone horizontally laid. No mortar. Angular stone size 0.6x0.5m to 0.1-0.15m roughly squared. Depth is variable but generally 40-60mm. Over the centre of the arch single stone depth but increasing in depth as the arch curves away on both sides to join 2006 infilling.
2003	Structure	Culvert side wall West- Canal wall	W up to 1m		Canal wall (SW side) constructed of squared sandstone laid to courses bonded by greyish/white mortar. With shale flecks, coal flecks, hard textured, variable sized stone. Mostly large blocks but isolated small stone to infill gaps. The elevation is vertical and neatly constructed to present a fair face. Behind the lining stone, smaller irregular shaped sandstone is used with no apparent pattern. 2003 is not as 2004 the opposite side due to a deviation of the original construction to allow a drain or topping up of the water channel to enter the main line of the canal. At this point there is a curve to the wall which then straightens out to be parallel to wall 2004. The full width of the canal continues to the north, whilst to the east of the drain the canal is narrower in width. From the drain junction to the west the wall line is straight for at least 4.6m. This coincides with the metal slag deposit probably representing a ramp for assisting with unloading or loading barges. Further exploration of the line suggests it curves to the north. Where the change occurs is not yet known. The canal wall at this point may have deliberately been lower to allow the Fe to be emplaced

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					but a combination of the stone and Fe formed an edge to match the height of the opposite wall 2004.
2004	Structure	Culvert side wall (east) Canal Wall	length>37m width 0.6-0.9m	1.5-1.6m	Canal wall constructed of squared sandstone (random, built to courses) bonded with hard greyish white mortar flecked with shale and coal. Stone size variable mostly large blocks but isolated smaller stones used as infilling. Elevation vertical and neatly presented. Behind the lining smaller irregular shaped stone used to fill between the cut and the facing elevation. Front lining about 0.4m in depth max to 0.2m in depth but all stone neatly aligned at front variable to rear where it joins the rubble infill in the cut. Possibility that opposite the drain and the Fe slipway at the narrowing of the canal that the wall has been strengthened in thickness-reinforced. There appears to be a maximum width at this point lessening the further one moves away to about 0.5m in width. Coal dust at surviving level of wall unknown whether in place prior to canal build of later build up (probably later)
2005	Structure	culvert arch brick	width 1.17m	1.2/1.3m	Brick built tunnel/culvert comprising double row of bricks on edge with soft whitish grey mortar with coal flecks and shale flecks. Occasional breaks in surface presumably to allow visual inspection of silting or that water is running.
2006	Deposit	Fill between capping and walls	width variable	1.3m	Fill of irregular but tending to blocks of sandstone deliberately placed flat to fill the gap between the canal walls and the culvert 2005. Large and small stone used. No mortar but gritty shale small stone and coal dust filling the voids. Stone on edge to face noticed particularly exterior to the canal walls. Greater care has been paid to the exterior brickwork of the culvert in placement. Stone effectively stacked one on top of another but not interlocked particularly.
2007	Deposit	culvert channel silt		1m	silty fill within culvert 2005, very fine particles, no stone

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2008	Deposit	natural clay in culvert		1.3m n.b.	Possible natural clay forming the base of the canal. Slightly greenish tinge to the yellow brown clay possibly the results of salts in the water. Unlikely to be puddling clay
2009	Structure	stone wall	23m minimum length 1.05m width	1.1m	Stone wall running e-w parallel with flue. Stones are randomly coursed and roughly faced on either side. Largest stone - 0.6x0.4x0.15m. The wall is bonded with a crumbly grey mortar with black and white flecks in some places while in other areas the wall seems to be bonded with a white mortar.
2010	Structure	brick floor	8.1m length 0.75m width	0.7m n.b	Yellow brick floor/wall adjoining flue 2011 to the south. Bonded with a hard cream coloured mortar. The bricks appear to change colour from pale yellow to red/orange nearer the flue while the mortar becomes bright yellow orange. The level of the bricks steps downwards towards the eastern end revealing 15 courses in doeth from the far west to the east. The bricks do not seem to have been laid in any pattern.
2011	Structure	brick arched flue	43.05m length (not fully exposed)		Full extent not seen fully to the east. Side walls to an arched flue. Constructed from a variety of bricks measuring from 0.23x0.11x0.06m with crown and Stourbridge stamps to the large blocks measuring 0.54x0.3x0.08 used in the arched roof. The bricks are heavily vitrified in places on the internal face. It is bonded with a hard cream coloured mortar, the external face is not visible to the south but to the north a pipe 2273 has destroyed and potential outer features/faces
2012	Structure	Floor of flue 2011			The floor of the flue running E-W is comprised of yellow bricks being bonded by a light brown mortar. Throughout the span of the floor are a number of pillar bases (2377). The walls of the flue are bonded with the base. The full extent is not seen [2011] to the east
2013	Structure	2 linear stone structures crossing E-West over culvert			2 linear stone structures crossing E-W over the culvert/bridge for tram access in poor condition. 1 face is possible to see (southern) 2 pins located 1 on the north face of the southern linear and another loose in the central area. Extent of the E and W of this structure not known as of yet. The pin found in-situ (on north face of southern linear) is the smaller of the 2. North side 2021 south side 2022
2014	Structure	western brick inspection hole	0.95m length 0.7m width	0.82m	Western brick inspection chamber hole of drain 2019. The drain leads to brick inspection chamber 2015. Depth to base of 2014 is 0.82m from top of brick chamber and 0.6m to the base of brick chamber
2015	Structure	eastern brick inspection chamber	1.2m length 1m width		Brick inspection chamber similar to 2014. This chamber is larger however and there is a linear cut 2017 extending north to south. Not excavated to full depth so depth is

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					unknown. The bricks are red brick and firebrick (yellow) and measure 0.24mx0.105mx0.08m The mortar is dark grey very hard mortar with white flecks
2016	Deposit	natural clay			Natural clay seen north and south of iron capped drain 2019 and inspection chambers 2014 and 2015 cut by 2017 by deposit 2018
2017	Negative feature	cut into 2016			Cut for 2016. This runs n-s and at the southern end heads east and always parallel with culvert 2003
2018	Deposit	fill of cut 2017 abut 2003			Very black clay with coal dust and coke inclusions. Runs parallel to culvert 2003 and is cut by drain 2019 and inspection chamber 2015
2019	Structure	Iron capped drain	2.2m length 0.82m width	0.05m depth	An iron capped drain. The iron caps are heavily corroded and rusted. Three caps are visible which measure 0.7m length approximately. The cap the brick drain 2024 and 2025. Smaller Fe overlies join of larger two
2020	Negative feature	cut for 2014 through 2016	1m width length>4.5m	1m	Cut for manhole east west orientated appears near vertical slightly wider to the upper part structure built in leaving about 50mm fill between cut and brickwork on the south side and tight to cut on the north side.
2021	Structure	north side of tram crossing 2013	1.7m e/w 0.3m wide	0.15	Broadly linear arrangement of large angular sandstone that appear to form an e/w alignment on their southern edge alone. Stone size 0.2x0.4m loosely butted together no mortar. Stone not dressed likely quarried and breaks naturally. This alignment not as clear as the edge to the south - the other side to the possible tram crossing (2022)
2022	Structure	North side of tram crossing	1.7m e-w 0.47m width	0.15m	Linear arrangement of 4 undressed large sandstones forming a straight edge on their north side, parallel to 2021, likely the matching edge to a tram road crossing. Width between both edges 1.1m. Possibility that a layer of protective stone 2002 also placed between kerb lines to protect 2005 arch culvert but not enough to prove definitely. Survives to edge of 2005 to the east only. No indication of the tram road line to the west of the centre line of culvert 2005
2023		VOID NUMBER			VOID NUMBER
2024	Structure	N facing wall of drain 2019		0.6m as excavated	The north facing elevation of drain 2019 full extent not visible due to the iron caps 2019. Brick built, unknown number of courses, one course wide. Dark grey mortar, redbrick. Brickwork descends to the east.
2025	Structure	s facing elevation of drain 2019		0.6m?	The south facing elevation of drain 2019. Brick built unknown number of courses deep due to water level, one course wide. Dark grey mortar, redbrick. Brick work descends towards the east.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2026	Deposit	Basal deposit N end of shallow bay			VOID NOT FOUND
2027	Structure	Brick base			Floor or base comprised of yellow firebricks (18"x12"x4" thick) showing signs of cracking by heat. One complete brick seen, parts of two others. Feature likely continues to north and east but cement based asbestos present *no further recording made* Base covered over because of contamination. Underlies mixed fills.
2028	Structure	Brick wall/ base	0.68 e/w 0.24m n/s	unknown	Brick wall/base comprised of standard brick (0.22mx0.115mx0.065m) bonded with a hard gritty grey coloured mortar with coal/coke flecking laid flatbed. Single brick step up noted to east. Probably damaged step not intentional. This base, south edge in line with floor 2029. Further recording not undertaken due to asbestos contamination. Wall/base constructed of yellow refractory bricks laid in alternating header and stretcher bond and bound with a grey coal/coke rich lime mortar. Structure survives to 4 courses 0.3m with a length of 1.47m but appears would have extended along full length of excavation area 3..87m and beyond both east and west sides. Within the excavation area it was possible to view that the western end of the wall has been removed. A single broken aqua glass bottle was recovered from close proximity to the structure. This was embossed with Hansards pure aerated water Merthyr on the front and Hansards vertically on the back. A date of 1904 was embossed on the base (company dated all of their glass bottles) and at the base of the vertical Hansards on the back immediately below the S are the initials S.W.G Co which indicates the bottle was produced by South Wales Glass Company of Newport.
2029	Structure	Brick floor	W-1.22m x 1.15m x 0.07m; E-1.25m x 1.04m		Refractory brick flooring either side of Fe plate 2469. Western area laid in stretcher bond whilst eastern area laid in combination of header and stretcher bond. Matrix consists of a firm grey coal/coke rich mortar. Bricks appear to unfrogged and devoid of any manufacturing marks. Full extent of surface unclear as it appears to continue beyond both east and west side of excavation area. Brick dimensions 220mmx100mmx70mm
2030	Negative feature	pipe trench	0.5m wide	up to 1.4m	Trench cut for ceramic pipe, Cuts across site upper level of trench unknown no cut differentiated in overburden of fill covering the site. Probably related to Thorn site. Continuation of similar drainage seen a site possible T junctions present.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2031	Object	Ceramic pipe			Light yellow brown glazed ceramic pipe 11" external diameter 9" internal diameter. Surrounded by hard concrete with stone chippings
2032	Negative feature	pipe trench	9.8m length 0.7m width		Trench cut for ceramic pipe, original depth indeterminable in excess of 1.4m deep. Possibility that it originally joined cut 2030 to form a junction. This pipe leads to manhole 2034
2033	Object	pipe	12" exterior diameter, 9" interior		Ceramic pipe 0.3m external diameter with dark brown glaze encased in concrete with chippings at least 0.1m all around in thickness. Pipe enters chamber 2034
2034	Structure	brick manhole/inspection chamber	1.05m square	1.3m surviving	Red brick chamber constructed within earlier buildings. The upper part is well made, the lower 0.9m displays foundations not on view and roughly finished. The base to the south extends outwards for 0.4m from the top stepping out as it does so. Hard white cement mortar bond. Alternate courses of headers and stretchers - 18 courses visible, brick frogged (single sided depression) Internal rectangular inspection hole 0.6x0.56m. Top of structure truncated bottom not proven
2035	Negative feature	pipe trench and manhole trench			Intrusive cut to emplace manhole 2034. Dimensions difficult to gauge at least 1.6m (E/W) length possibly to structure 2059 (cuts 2088 2089) and 2032. All forming a network of drainage.
2036	Negative feature	pipe trench			Pipe trench leading to MH2034. Originally seen whilst machining but later buried enters chamber and its SW corner orientation likely NE/SW
2037	Structure	ceramic pipe			Pipe seen whilst machining, since buried. No detail available but likely similar to 2033, 2031 with an internal diameter of 9". Encased in concrete as with other similar pipelines.
2038	Structure	brick chamber	2.6m x 2.06m	1.25m	Brick chamber - water outlet for 2049 and possibly for 2075. Not fully excavated due to asbestos found within fill 2039. Possible pipe connection with 2041
2039	Deposit	Fill of chamber 2038			Silty rubble fill of chamber 2038 contains brick rubble and mortar. Not fully excavated due to containing asbestos
2040	Object	metal pipe (cast iron)			Cast iron pipe running through duct 2044 in wall 2052. Consists of corner bend and 1 straight piece. Slightly corroded. Straight piece = 160cm long 10cm diameter bend piece = 38cmx38cm 10cm diameter joints = 2cmx 20cm diameter joints visible from previous connections
2041	Structure	brick chamber	internal 0.59m x 1.21m external 1.05m x 1.6m	0.96m	Brick chamber connected by pipe 2043 to floor 2047. Possible connection by pipe with 2038 brick walls (0.23mx0.11mx0.07m) bonded with light grey mortar max depth 0.96m max remaining wall height 1.13m contains fills 2042

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2042	Deposit	fill of chamber 2041			Total depth unknown-not fully excavated rubble/clay fill containing brick and pieces of iron
2043	Structure	pipe run	internal diameter 16cm external 18cm length 2.7m	original depth unknown	Pipe run visible from the remains of pipe built into two brick walls (2038 2041) located near the far west of the coal washery area. Remainder of pipe is no longer extant, was probably originally buried. Appear to join two small drains or probably drained into the contained by 2038 unable to tell whether the pipe is a later addition to the walls but as the drain would have no other purpose they are almost certainly contemporary. Pipe is brown glazed cream fabric ceramic. Bonded with mid grey coal flecked mortar
2044	Structure	duct	270mmx500mm s side-285mm x 250mm	610mm	Duct created by building on rectangular gap into brick wall 2052. Probably a later insertion as the brickwork on the inside of the duct is damaged and rough. Tapers internally inside wall getting narrower towards the south acts as a duct for cast iron pipe 2040. Duct has lime residue on the roof, probably from water leeching out the lime from mortar
2045	Structure	duct	unknown		Duct shown on sketch map of the area built into wall 2052 between duct 2044 and brick drain/chamber 2041. No duct visible at time of completing context sheet
2046	Structure	mortar and brick floor	1.47mx1.57m irregular		Rough floor surface made of brick and mid grey hard mortar that has a texture like concrete. The eastern part of the floor is covered with a slag deposit with the remainder being brick and mortar. The wall is bounded east and north by wall 2052 and the floor drops away to the south onto floor 2047. there is evidence the floor had a plaster surface. Ceramic pipe 2043 bounds the floor to the west but it is unclear whether the floor once extended over it. It may have once extended further west
2047	Structure	brick floor	1.85m x 1.34m		Brick floor forming a surface at the far west edge of the coal washing area. Bounded to the north by floor 2046 and east by wall 2052. Stub wall projecting from 2052 forms the south of the floor boundary. Floor is made of red brick bonded with a mid-grey hard mortar. It has slightly convex surface and may originally have served as a water management feature as pipe 2043. Opens to its north and the remains of Fe pipe duct 2152 are located to its east. There is a build-up of slag on the floor to the east near the duct for the pipe 2125
2048	Deposit	fills between walls/floor	86cm x 153cm		Yellow silty clay fill between wall 2052 and floor 2046. Total depth unknown as not fully excavated. Thin layer of charcoal covering parts. Contains small stones and brick fragments possibly continued south

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2049	Structure	washing/ settling tank	w-1.53m min w-2.25m max		Washing settling tank walls are 2052 located at end of floor 2252. Total depth unknown due to bottom full of rubble and water. Timber post in the two eastern corners parallel with slope of east edge. Gradual slope on the eastern edge, steep slope on the edge connected with the floor 2252. Overflow pipe leading into 2038 on the N side.
2050	Structure	duct and timber recess	1.45m max 1.22m min w-0.35-0.1m		Duct and timber recess in wall 2052 N edge has remains of timber strip and iron pin in north east corner. Brick lining on east edge of base (bricks 23cmx11cmx8cm)
2051	Group	Brick bay with Fe rails and setting tank			Group number consists of 2252/2052/2049/2112/2113/2114/2115/2116/2117/2119/2120/2121/2122/2123/2050 see individual contexts for details
2052	Structure	brick wall to bay 2051		max height 1.16m	brick wall surrounding features within group 2051. Bricks roughly 23cmx11cmx8cm and bounded with light grey mortar. English bond construction alternate header and stretchers interior elevation displays traces of cement rendering as does the floor to the bay. Exterior of wall not fair faced, mortar left roughly not to be on view. Possible the bay dug into existing fills. Chute to east. Chute face rendered but not where timbers present, one on east side following the batter of the slope. Timber 10" by 15" rectangular presumably for hauling something up a lifting chain. Recess in wall interior opposing pairs 16" up from and in line with the timber in the base. Recess height at least 0.29m high by 0.15m wide likely second row of timbers? If so then there is a narrow gap between the floor and underside of these. It is not known if they extended from side to side.
2053	Structure	Brick Base	2.9 x 2.41m	0.2m	A stone/brick floor or base which appears to have been truncated to the north/east and south. It is constructed of stone up to 0.36m in length and both red and yellow brick bonded with a light grey mortar with black and white flecks. It seems to have been built as a series of E-W linears which have been mortared together. The eastern extent is butted by a row of red brick 2 courses deep. The top row is laid on edge and the lower row flat. The eastern side of the feature overlies slag and industrial waste material, and pipe 2054, while the west side overlies clay.
2054	Structure	Pipe Run	Internal diameter 0.1m; length 2.19m		The length, assuming it continues complete under 2053 is 2.19m with a collar at the southern end. Contained within a deposit of slag and industrial waste material.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2055	Group	Hopper reservoir			Reservoir/cooling tank with 2 phases of construction. Initially made using yellow bricks (23x11x7cm) bonded with grey mortar with flecks of charcoal. Then later re-lined with red bricks (23x12x7) and bonded with light grey mortar. The upper parts of the walls are severely damaged. See sketch No.7. The internal sloping brickwork is header course at higher level then changes to alternate headers/stretchers (English Bond). At least 12 courses of headers and 6 courses of English Bond visible. However the likely central point bricks are stretcher bond only. In each of the four corners and following the angle of the batter is the staining of timber posts. Rust staining suggests an Fe element to the timber or a fixing point. The rest follows the angle of the timber. The timbers are 5 inch square section, rust staining 8 inches out from the corners. Possibility that this was built into an existing structure evidenced by the brickwork cutting through masonry and brick to the southwest. Massive brick conglomeration at the 'control point'. This feature is a rectangular bay with straight sides and opposing rectangular blocks projecting out of the, which are capped by metal on all sides. The whole block could be metal. The top of these iron blocks are sealed by brick. Fe blocks are brick filled, probably evidenced by brick visible on their east faces. Red brick fair faced batter 0.4m in depth before abutting up to earlier yellow stonework. No superstructure surviving. Structure probably open Fe structures 0.47m in from the corner (sluice?). Distance between 1.98m (6'6) water could cover these blocks. In plan to the east of the Fe blocks the walls began to taper inward. Water level didn’t drop to see the base but the fill comprises timber, brick, iron rods and bars, plate with holes (boiler plates?) and gritty dark grey small stones and coal fragments in a black silty coal clay. Possibly imported fill?????
2056	Deposit	Fill/natural clay between walling			Mixed clay fill covering large area to an unknown depth west of 2051
2057	Structure	pipe (Fe/cast iron)			Pipe made of cast iron and found embedded underneath the surface 2053, from which it emerges on the north side of 2054 it protrudes 24cm from the soil and the inside has a diameter of 12cm.
2058	Deposit	Fill/Natural between walling			Fill of clay and industrial waste material between walls 2098 2099 2060 similar to 2056, contains stone of various sizes
2059	Group	red brick structure			Group number for foundation for distributing screw mechanism.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
		incorporating wooden sleepers			
2060	Structure	brick base/floor chute to north	0.92 n-s 0.91 e-w		Base slopes downwards to the north with the base of slope terminating 0.3m above brick floor 2072 comprises red brick bonded with a light grey mortar. See sketch on reverse the south and west facing faces of the base are very irregular and not faced to be viewed
2061	Structure	Pipe	0.3m (south of wall 2096) 0.1m diameter		Cast iron pipe protruding from the south side of 2096 but does not show on the north face of the wall. Route appears to be the same line as 2054 collar visible as enters wall.
2062	Negative feature	modern but through 2051	see detailed sketch on reverse		Modern cut through floor 2252 and wall 2052 at south end of 2051
2063	Structure	chute/ramp	3.5m x 2.34m		Chute/ramp located at the east end of 2074 made up of yellow bricks 21cmx8cmx8cm wooden beam across the bottom edge. There is an indentation in the brick work at 69cm from the west edge for approximately 0.5m and is the depth of one layer of brick. Part of group 2059.
2064	Structure	chute/ramp	121cm x 4m		Chute/ramp made up of yellow bricks (26cmx6cmxwidth unknown) going horizontally and in a type of step. Bonds with light grey mortar which also completely covers the bottom part of the slope making it a smooth surface. There are also some stone and red bricks within the structure top edge is made up of red bricks measuring 23cmx12cmx8cm and create a joining point with wall 2099
2065	Structure	chute ramp	min w-63cm max w-1.21m min l-1.17 max 4.45m		Chute/ramp comprising mostly of yellow brick (25cmx10cmx7cm) running horizontally bonded with light grey mortar the bottom part is also covered in a dark grey mortar. Wider at the bottom than it is at the top. Large patches or mortar are also covering the top area possibly used to make the chute smooth. Possibly adjoining 2068 but unclear
2066	Deposit	fill of cell with chutes		min 3m n.b	Fill containing industrial waste material including slag, Fe, brick stone and mortar
2067	Deposit	fill of cell south of chutes		min 1m n.b	Fill contains high quantity of brick, slag stone and mortar, industrial waste material, (coke ,ash, coal) and demolition rubble
2068	Structure	yellow brick wall	4.5m (e/w) 0.41m (n/s)	1.4m min n.b	English bond yellow brick wall bonded with a grey mortar with black flecks. Fairly large gap between bricks. North and south faces are meant to be seen truncated on its eastern side. Relationship to chute 2065 unclear.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2069	Structure	yellow brick masonry wall	6.02m E/W 4.8m N/S	1.45m depth	Masonry wall roughly faced to the south and west bonded with a light grey mortar with black and white flecks. The eastern end is bonded with a yellow brick area which forms an inner face to the north and east. Stone up to 0.54m in length. The brick area is bonded with the same type of mortar as the stone area.
2070	Structure	yellow brick wall	2.3m length 0.37m width	1.3m n.b	Yellow brick wall truncated to the north and to the south. Bonded with a grey mortar with black and white flecks. English bond fair faces to east and west. Probably would have been bonded to brick part of 2069
2071	Deposit	fill in passages group 2051		up to 0.9m+	General fill in brick passage consists of demolition rubble slag timber and iron debris in small quantities. Not visible at time of writing context sheet
2072	Structure	brick floor group 2059	1.37m wide 17.75m length		Red brick floor forming the base of brick channels for group 2059. The floor forms the northern most branch of floor of a broadly T shaped channel. The bricks are laid in stretcher formation with some cut to size to accommodate five beam slots in the floor. Bonding is hard grey mortar and there is some evidence of iron staining from prolonged contact with Fe objects. The floor slopes down from east to west dropping as much as 0.5m+. Each beam slot is 1.68mx0.31mx0.15m deep. The floor is damaged at the eastern end where a slot has been excavated through much of 2059 and the surrounding area. The damage has caused the floor at this end to slump south and also demonstrates that the floor in this area is only one brick thick resting on stone and loose rubble
2073	Structure	brick floor group 2059			Red brick surface forming part of brick channel 2059. Brick are laid large surface up and have an eroded appearance. Surface slopes down for south to north dropping to meet the final fill of surface 2072. Some bricks show evidence of prolonged contact with Fe in the form of iron staining. Timber beam 2077 may sit on the surface of 2073 acting like a fill for surface 2074. The bricks are bounded with black/grey mortar but the colour may be caused by water.
2074	Structure	Brick floor group 2059	west-2.37(L) east-1.88m(L) width-1.42m Max		Red brick floor laid on edge with no apparent bonding truncated in the centre for possible timber. May overly an earlier yellow brick floor seen at the eastern end. Mortar at the eastern end and overlying the yellow brick
2075	Structure	brick floor group 2059	3m length 0.74m width		Brick floor with no bonding mortar between walls 2094.2052 and 2039. Ends to the east at floors 2072 and 2073, (sketch on reverse)
2076	Object	Timber plank part of sleeper group	1.64m L 0.31m W	0.1m	Piece of wood overlying floors 2072 and 2073 surviving no obvious purpose. Not set within a cut like other sleepers. Survives fairly intact.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2077	Object	timber sleeper, group 2059	30cm x 138cm	6cm	Timber sleeper at west end of 2074 has 4 iron pins, 2 at north end and 2 at south end. Overlies 2073
2078	Negative feature	recess in base of floor 2072	32cm w 168cm l	14cm	Recess in floor 2072 containing timber 2106. Goes into walls 2090 and 2099. Contains 3 iron pins 2 at south end and one in the middle
2079	Negative feature	recess in base of floor 2072	1.67m n-s, 0.33m e-w	0.15m	A recess in floor 2072 and walls 2090 and 2099. recess to hold timber 2107.
2080	Structure	recess in floor 2072	43cm-w 156cm-L	3-10cm	Recess within floor 2072 containing timber 2108. Also goes into walls 2099 2090. Contains 2 iron post to secure the wood onto.
2081	Structure	recess base of 2072	167cm L 31cm W	12cm	Recess within floor 2072 containing timber 2109. Cuts into wall 2090 2099 contains 2 iron posts in the south end and 1 in the middle. Base is mortar (light grey-same as floor 2072 bonding)
2082	Structure	Recess base of floor group 2059	0.35m x 1.45m	0.15m	Recess at the East end of floor 2084 containing timber 2110. The south end is demolished, therefore full length could not be established. Continues into wall 2090 contains two iron posts/pins in the middle to hold the timber 2110 in place.
2083	Deposit	Fill between walls		1.40m	General rubble/waste fill. Contains stone and brick. Similar to 2066 and 2067. Total depth unknown due to not being fully excavated.
2084	Structure	Brick floor group	0.73m x 0.72m	0.15m	Layer of bricks, part of floor, 2072. Consists of red brick (8x22x10cm) and bonded with light grey mortar. Cut by 2086 on the west edge and 2082 is on the east edge. Overlies foundation 2085.
2085	Structure	Stone blocking / Foundation	0.66m x 0.86m	0.73m	Stone blocking / foundation of 2072 and 2084. Partially visible due to cut 2088 and 2086. Consists of masonry stone with little or no mortar for bonding. Stones appear to be about 0.3m long on average.
2086	Negative feature	Cut through floor 2072 group 2059	0.66m x 0.86m	0.11m	Cut through floor 2072 East end and 2084 west edge. Contains reveals foundation 2085.
2087	Structure	Brick foundation	0.48m x 0.49m	0.3m	Red brick foundations (bricks = 22x12x8cm) bonded with light grey mortar. Appears to continue under 2082. The part that is visible appears to have been damaged by cut 2088.
2088	Negative feature	Drainage cut N/S	W 1.4m	1.2-1.51m	Cut through 2101 and 2102 for modern drainage pipe. Same as 2089. Min depth on wall 2101 is 151, on wall 2102 is 1.2m. Possibly continued on North to cut through 2072, 2084, 2087, 2082 and 2085.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2089	Negative feature	CUT	1.1m W 1.27m H		A cut has been made in walls 2068 and 2103 and although manhole is located south of the cut there is no evidence for a drain or pipe for drainage. The cut appears to be part of a larger cut appearing north and south and cutting through a number of walls.
2090	Structure	Brick wall E/W North side 2059	18.22m L x 0.48m W x 0.94m H		Red brick wall E/W aligned forming the north wall of group 2059. Bonded with hard mid grey mortar, built English bond style for the rest of its length. Survives to 10 courses at max. Contains 5 recesses for timber beams set into floor 2072 and a cut 2030 for a ceramic drain pipe. The external N elevation is roughly finished and was probably designed to be buried. The internal S elevation central section has a header laid stretch that suggests a Feature once sat above that has been destroyed.
2091	Structure	Brick Insert Group 2059	1.5x0.25m x 0.28m H		Section of red brick inserted into yellow refractory brick wall 2129 bonded with hard grey mortar. May block what once was a break in but this is unclear. Survives to 3 courses height with brick laid headers on.
2092	Negative feature	Cut for brick insert 2059	1.5m x 0.25m 0.28m H		Cut in wall 2129 to allow placement of red brick insert 2091.
2093	Structure	Brick Wall Group 2059 N/S	0.94m H x 0.47m W x 4m L		Red brick wall bonded with hard grey coal flecked mortar forming the western edge of group 2059. The external face is roughly finished and was probably intended to be buried. The wall survives to 10 courses in height and the wall is 3 bricks thick.
2094	Structure	Brick wall group 2059	0.22m Thick x 0.66m high x 3.07m L		Red brick wall bonded with hard white/grey mortar forming one side of a brick drain channel 2075. The wall is rough finished on the external north aspect and intended to be buried on this side. Internally the wall survives to 8 courses max but only to 6 for the majority of its length.
2095	Structure	Brick wall group 2059 N/S	0.18m x 0.47m x 1.56m L		Remains of a red brick wall forming the SW extent of brick channel group 2059. Bricks are bonded with hard mid-grey mortar and the wall survives to two bricks in height. Abuts walls 2096 and 2052 separates the channel of 2059 from fill 2056.
2096	Structure	Brick wall group 2059 E/W	6.7m L 0.56m 0.45m		Red brick wall bonded with hard grey mortar forming the S exterior of the brick channel 2059. The wall is damaged, barely surviving to the east but up to 6 courses in height towards the west. The wall accommodates a partial recess for timber beam 2077 similar to those seen on the northern part of the channel. The external (southern) elevation is rough finished and was intended to be buried, the wall throughout being of English bond construction. The external face, towards the west contains Fe pipe 2061 but no sign of the pipe can be seen on the internal face.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2097	Structure	Brick wall group 2059 N/S	0.37m W x 0.91m H x 2.93m L		Red brick wall bonded with hard grey mortar forming one of the walls for brick channel group 2059. Survives to 10 courses maximum and is damaged to the north, whereas iron plate measuring 0.17m x 0.28m can be seen built into the wall. Only the west elevation of the wall can be seen, the rest being hidden by walls 2098 and 2060.
2098	Structure	Brick wall group 2059 E/W	0.45m W x 0.54m H x 3.9m L		Red brick wall bonded with hard grey mortar forming an E-W wall in the southern part of the brick channel group 2059. The wall is much damaged, surviving to 6 courses at most toward the west and only as a mortar mark at the east. The external (north) elevation is roughly finished and probably intended to be buried.
2099	Structure	Brick wall group 2059 E/W	0.65m H x 0.46m W x 12.6m L		Red brick wall bonded with hard grey mortar forming one of the walls of brick channel group 2059. Survives to 7 brick courses maximum and is cut by the course of ceramic drain 2030 and has further damage near its eastern extent. The walls internal elevation accommodates 3 recesses for the insertion of timber beams set into the floor surface. The external (south) elevation is roughly finished indicating it was meant to be buried. One section of wall has been utilised as part of a chute 2054 but not enough survives to say whether this section is re-built or modification.
2100	Structure	brick wall edge chute 2064 N/S	1.2m n-s 0.4m width	2m approximately	Yellow and red brick wall forming the eastern boundary for chute 2064. Appears to be truncated to the south and the top. English bond visible on west face, eastern face not visible due to spoil upper part of wall red- lower part yellow bond with a grey mortar.
2101	Structure	brick faced masonry wall e/w	3.8m length 0.91m width	2.6m n.b.	Masonry wall with stone measuring up to 0.5m in length bonded with a hard grey mortar with black and white flecks. The north side appears to be roughly faced while the south has a bonded yellow brick face English bond with grey mortar. Brick face may have a small recess similar to the opposite facing wall. This recess measures 0.32m width x 0.36m height with a depth of 0.12m
2102	Structure	Brick faced masonry wall	0.8m-L 0.92m-W	1.5m	Same construction as 2101. Wall 2129 appears to have been a later addition
2103	Structure	remnant of brick wall part of 2063	0.17m-L 0.38m-W	0.67m	Remnant of yellow refractory brick wall, once part of 2063 and bonded into wall 2129. The stub has been cut by 2049 to the west. The bricks measure 0.24x0.075x0.11m and are bonded with a hard grey mortar. Mortar residue on the wall behind (2129) suggest the wall was originally at least 1.42m high. The stub is wedge shaped and severely damaged. The bonding with 2129 is only evident at the base of the stub which survives to 8 courses.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2104	Structure	brick faced masonry edge chute 2063	0.98m thick, 5m length 0.93 external, ?up to 2.7m		Brick and stone wall forming the south wall of brick chute 2063. External (south) wall in stone blocks 0.31x0.34mx0.15m average laid in 7 surviving courses. Some yellow refractory brick has been included. The internal north face is all yellow refractory brick (0.24mx0.13mx0.075m) The wall throughout is bonded with a hard grey mortar. The brick elevation contains a diamond shaped recess to hold a timber beam and has two phases of Fe staining suggesting contact by Fe plates, both stains run parallel to the slope of rick chute 2063. The external face is roughly finished suggesting it was intended to be buried, though the stone itself presents a nice fair face, possibly re-used from a previous structure. The western end of the wall is cut by pipe run 2030 and the eastern end is badly damaged, with the corner of the wall only surviving at a lower level. Butted by general fill 2056 at the south, brick phase is 32 courses high.
2105	Structure	brick aced masonry edged chute 2063	5m long 0.96m thick	3m internal height	brick and stone wall forming the north wall of brick chute 2063 forms the opposite wall to 2104 and is virtually a mirror image although it survives to a greater extent. External (north) face is stone as for 2104. Internal south face is yellow refractory bricks. The external elevation is roughly finished suggesting deliberate burial. The internal elevation contains a damaged recess probably once diamond shaped to receive a timber beam. Two Fe stains mirroring the ones 2104 can be seen running parallel to chute 2063. The wall is bound throughout with hard grey mortar. The wall is bonded with N/S wall 2128 and is almost certainly contemporary. The stone block measure an average size of 0.34mx 0.16x0.3 the bricks measure 0.25mx0.12mx0.075m where complete
2106	Object	timber sleeper in 2078 recess group 2059	Three fragments largest 0.26m x 0.12m x 0.06m		Remains of timber sleeper contained by brick recess 2078. Very fragmentary only surviving where the wood has adhered to three iron pins. See 2107 for description of pins and method pf inserting beams. The pins are very rusty
2107	Object	Timber sleeper on 2079 recess group 2059	1.25m x 0.2 x 0.16m		Remnants of timber sleeper with 4 iron pins. The timber is damaged and rotted, but probably once filled the beam. The pins are circular in section with a square plate at the base for attachment. Fe staining on surviving timber suggests contact with iron 'rails' but the positioning of the pins would make a rail system impossible. More likely to be a support for a structure made of iron. Evidence of screw thread on at least one pin. This is the most intact sleeper of the series of sleepers on this side.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2108	Object	timber sleep In 2080	0.71x0.25x0.2m		Remains of timber sleeper contained by recess 2080. The wood is decayed and only survives to the south of the recess, where two iron pins have held it together. See 2107 for description of pins and method of inserting or replacing sleeper
2109	Object	Timber sleeper in recess 2081	n/a		Remains of timber sleep in brick recess 2081. The timber has mostly decayed away and survives only as residual remains adhering to three iron pins. See 2107 for description of pins and method of inserting/replacing
2110	Object	timber sleeper in recess 2082	2 pieces 0.51x0.09x0.13-0.4x0.12x0.1m		Remains of timber sleeper contained in recess 2082. This is the easternmost sleeper and although the recess is damaged there appears to be no discernible difference in the form. The beam is mostly decayed surviving remains adhering to two iron pins. See 2107 for description of pins and method of inserting/replacing timbers
2111	Negative feature	cut through wall 2099	115cm max 37cm min	55cm	U shaped cut into wall 2099 down the base of the wall
2112	Object	timber sleeper in group 2051	15cm x 240cm		Timber sleeper in floor 2252 south end. Part of bay 2051. Runs under iron railing
2113	Object	Timber sleeper in group 2051	15cm x 239cm		Timber sleeper in floor 2252 part of bay 2051, runs under iron railings some slight damage on the north side
2114	Object	Timber sleeper in group 2051	233cm x 12cm		Timber sleeper in floor 2252 continues under iron railings.
2115	Object	Timber sleeper in group 2051	15cm x 221cm		Timber sleeper in floor 2252. Part of 2051
2116	Object	timber sleeper in group 2051	15cm x 221cm		Timber sleeper in floor 2252, part of group 2051 continues under railings damaged on the south edge
2117	Object	Timber sleeper in group 2051	220cm x min 9cm/ max 14cm		Timber sleeper in floor 2252 damaged along all of the north edge and part of the south edge continues under iron rails. Part of 2051. Most northern sleeper in bay
2118	Object	Pipe through wall 2052 (overflow)	diameter interior 16cm/exterior 20cm length 20cm		Iron pipe running through wall 2052 connects settling tank 2049 and chamber 2038
2119	Negative feature	recess in wall 2052-timber slot	17cm x 20cm	29cm	U shaped timber slot in the east facing west wall of 2052, slightly off line with timber sleeper 2117
2120	Negative feature	Recess in wall 2052 - timber slot	16cm x 20cm	10-19cm	U shaped recess in the east facing west wall of 2052 lines up with timber sleeper 2116 full height depth cannot be determined due to damage to the wall.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2121	Negative feature	Recess in wall 2052 - timber slot	20cm x 16cm	20cm	U shaped recess in east facing of west wall of 2052. Part of 2051. Lines up with timber sleeper 2115
2122	Negative feature	recess in wall 2052 - timber slot	22cm x 15cm	10-19cm	U shaped recess in west facing of east wall of 2052. Possible timber slot aligns with timber sleeper 2114. Part of bay 2051
2123	Object	Timber included in tank 2049	approximately 21cm x 8cm and 12cm x 12cm		Two pieces of timber in the NE corner of tank 2049. Run parallel with the east sloping edge of the tank 2049. Total length/height of timber unknown due to tank full of water.
2124	Object	Timber included in tank 2049	45cm x 12cm		Piece of timber in the south east corner of the tank 2049 total depth unknown due to continuing beneath the water level. Heavily damaged. Run parallel with the slope of the east side. Possibly made up of three pieces of timber
2125	Object	Fe pipe and plate through 2052			Iron plate on either side of west wall of 2052 and iron pipe connecting the plates running through 2052 severely corroded, pipe smaller on west side
2126	Structure	brick facing wall 2104 chute	215cm- l 25cm-w	3m	Yellow brick wall along the edge of chute 2063. Brick facing bonded with wall 2104. Bonded with a light grey mortar. Bricks measure 25cmx13cmx8cm. It contains recess with two possible iron staining lines running parallel with chute 2063. The east corner is damaged
2127	Structure	brick facing wall 2105 - chute			Brick wall composed of yellow refractory bricks and forming the south facing retaining wall for chute 2063. The north east corner is damaged but the wall almost certainly exterior ends west behind the line of the chute. It contains one recess 2204 for the retention of a timber beam and has two linear iron stains 2205 2206 running parallel to the angle of chute 2063. The faces of the bricks are more notably worn above the lines of staining than below possibly hinting at increased wear or friction above this line. Flanked to east by chute 2064
2128	Structure	walling west side of chute 2064	L-2m W-36cm	3m min	Brick wall along the west edge of chute 2064 consists mostly of yellow brick measuring 29cmx11cmx7cm with top 6 layers consisting of red brick measuring 21cmx11cmx7cm bonded with light grey mortar. The south corner is damaged but probably continued to join with all the edge of 2127
2129	Structure	yellow brick wall	10.87m long 0.72m width	3.25m-0.7m	Yellow brick wall 3 courses of brick wide, number of vertical courses are unknown due to limit of excavation. At northern end upon the south facing side true floor level has not been found although 30+ courses are visible at present and it appears to continue deeper in the rubble fill

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2130	Structure	linear wall	7.82m length 0.77m width	0.53m	Linear stone built wall which probably relate to early foundry site. The alignment of this structure is different to the surrounding walls thereby suggesting an earlier build date. The structure is truncated on both north western and south eastern ends by later structures. The bonding agent of lime mortar contains fragments of coal, butts natural on NW side suggesting interior of building, From viewing the NE side of the wall it appears that the walls sits upon the clay natural. The blocks of the wall are random coursed.
2131	Negative feature	cut for wall 2130			Masonry cut through orange natural on the western side and black possible occupation layer on eastern side. Cut into natural to construct the wall, runs parallel with wall 2130. Contained by wall 2130 and 2143.
2132	Structure	Chimney	2.3m x 2.9m		Potential chimney base constructed of yellow refractory bricks bonded with a coal/coke rich lime mortar. Bricks laid in an alternating header and stretcher bond of which 28 courses are visible. Floor of chimney also of brick construction. Flue 2241 accesses the west side of the structure whilst flue 2448 accesses from the east which may suggest the chimney provided a draw for hot gases and enable them to exit the works. South wall of structure constructed of yellow refractory bricks and red brick laid in a very rough un-coursed manner and bound with a grey coal/coke rich mortar which has also been sporadically applied to the wall face
2133	Structure	wall south of 2009 wall	13.4m length 0.89m width	1.08m	A predominantly stone wall with a few red brick inclusions measuring 0.89m(W) x 1.08(H) at highest point. Interior x 13.4m (L) full exterior extent not seen at eastern end. Bonded by a dark grey fill with charcoal flecks. Largest of the stones measures 0.38mx0.28mx0.12m the smallest of the stones measures 0.11mx0.1mx0.05m. The stones that form the wall are masonry stones and approximately 9 courses of stones can be seen. At 0.75m(W) measuring up from the lowest point of the interior of the wall, the wall steps back by 0.1m. Seems to abut the stone wall 2009 and overlay a clay deposit 2136. At 8.4m from the western most point interior of the wall a cluster of laid bricks can be seen all the bricks are red and stretcher lain bonded by a grey mortar seen underlying some of the masonry stones and overlying other. The brick cluster measures 0.64mx0.51mx0.13m. Predominantly one course but in one area 2 are seen. Could possibly represent either opening of rebuild or simply a course build of the walls with the better stone built face of the outside. . Some occasions the mortar changes between a light and dark grey-possibly representing rebuilds

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2134	Deposit	rubble fill between 2011/2009	4.6m-L 0.77m-W	0.6m	A grey colour silty industrial deposit containing rubble from the flue walls 2011 and brick dust along with some mortar. Also seen possibly containing stones from the wall 2009 seen as rubble fill between the walls 2009 2011 measures 0.77m (W) between the two walls x 4.6m (full extent not seen) neither east nor west. Seems to then underlie the black/dark grey deposit 2293 to the west
2135	Negative feature	Wall trench foundation cut	>10m length, 0.75m width	unknown	Likely machine cut edge for a trench to enable building of wall to coke ovens flue 2138 and wall 2009 in particular. Cut subsequently cut by 2284 the foundation trench for 2133
2136	Deposit	Fill of trench	7.2m x 0.75m	0.27m	An orange/red deposit (clay) containing a frequent amount of small and large pebbles. It is seen contained by the cut 2135 abutting the wall 2009 and underlying the wall 21353 partial by 1.65m from the walls western-most part to the east it is partially overlying the brick culverts 2005 by 0.33m and underlying the stones overlying the culvert 2002.
2137	Structure	Brick walling west end of flue	3.03m x 0.51m	0.99m	A brick formed wall, forming as the end wall (w end) of the flue structure, formed from yellow bricks, bonded by a dark grey mortar with charcoal flecks. It features approximately 10 courses and contains both stretcher and header lain bricks. Seen bonded with the e-w running walls 2011.Seen as a U shape the walls 2011 then continue east from this.
2138	Group	Southern coke oven flue group			Group number for flue. 2009-12, 2377, 2283-6, 2280-1, 2288, 2133-6, 2293, 2276-8
2139	Structure	Modern manhole chamber	1.2m x 1.14m	0.95m	Modern manhole chamber, only bottom part remains. Constructed with red bricks stamped with NCB TREDEGAR measuring 0.22m x 0.105m x 0.07m and bonded with grey mortar with no inclusions. Built onto a base of concrete at least 0.1m thick. It appears to connect with pipes. The south end of the chamber appears to abut the N facing side of the N 2011.
2140	Structure	Brick Wall	1.4m x 0.63m	0.5m	Small wall made of yellow bricks. Northern side is truncated but appears to be close to ending. Poorly preserved.
2141	Structure	Yellow brick walling	7.1m x 0.75m	0.95m	Yellow brick wall. On corner with 2143, original south extension is cut and replaced by wall 2142 made of stone. Evidence of this is the fact bricks are coming out of the corner and protruding onto the stone. Original height of the wall lost. On west side unclear if it is truncated or just a degraded face. On top circular hole is present, 0.15m across.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2142	Structure	Wall	1.7m x 0.66m	0.92m	A dark grey walling comprised of masonry stone and bended by a dark grey mortar. The larger of the stones measures 0.41m x 0.19m x unknown. The smaller of the stones measures 0.15m x 0.03m x unknown. The dark grey mortar contains some charcoal flecks. In one or two cases a yellow brick can be seen
2143	Structure	Yellow brick/stone wall	5.62m x 0.75m	1.13m Brick 0.61m stone	A yellow brick (predominantly) wall bonded by a dark grey mortar with charcoal flecks Featuring both stretcher and header courses the highest point of the wall measures at the lowest point at 1.13m. The wall contains approximately 13 courses. Underlying the brick courses at the northern most end of the wall a number of stone courses can be seen. It is unclear if this represents an older wall construction itself stone wall has been allocated number 2170. English bond wall all of brick.
2144	Group	Brick platform/base			Group number consisting, 2145-59, 2162, 2165, 2167, 2168
2145	Negative feature	Doorway (Group 2144)	w 0.79m	Min 0.92m	A doorway, part of group 2144 within wall 2148. Top edging is damaged, but the bottom is still edged. Filled with rubble, not fully excavated. The lower edging of the opening have been lined with red brick implying it was a later addition.
2146	Structure	Yellow brick wall 2744	8.5m x 0.72m	3.6m	Bonded with a hard grey mortar. Yellow brick wall English bond. The south facing elevation was excavated to a max depth of 3.6m but was not bottomed. It appears that where it meets 2173 some attempt was made to try and bond them. There are three recesses visible in the north facing elevation measuring 0.14m/0.13m/0.24m interior the wall from eastern to western other measurements shown on drawing. The central recess is one brick course lower than the other two.
2147	Structure	Brick walling group 2144	3.94m x 0.36m	0.5m	Yellow brick wall (English bond) within group 2144 bonded with a grey mortar with flecks of charcoal. Minimum height revealed is 0.5m. It is also adjoining with brick floor 2150 on the south side. The bricks measure 0.24m x 0.115m x 0.07m.
2148	Structure	Brick walling	4.15m x 0.36m	1.5m min	Wall within group 2144, constructed with yellow brick (English Bond) measuring 0.24 x 0.115 x 0.07m. Bonded with a grey mortar with charcoal flecks. It bonded with the west facing side of 2147 on the east end and is bonded with wall 2149 on the west end. At the west end is door 2145 which has been damaged at the top resulting in additional damage to the wall. It also contains fills 2163 with walls 2147 and 2146 on the north side and fill 2164 with walls 2147 and 2149 and floor 2150 on the south side. Fill 2163 has been partially excavated revealing part of the wall 2148 but fill 2164 has not been excavated at all, meaning the south facing of wall 2148 is not visible.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2149	Structure	brick walling group 2144	2.24m length 0.37m width	2m n.b	Yellow brick wall, English bond with a hard grey mortar with black and white flecks. Full depth was not excavated maximum depth seen on the west face, not excavated on its eastern face.
2150	Structure	Brick platform/base group 2144	3.89m length 4.94m width		Yellow brick platform, base of possible machinery. Square in shape although damaged bricks in areas. Grey mortar does not appear to be heat affected. Multiple brick layers used to construct platform/multiple courses. Possibly the same floor/platform as 2167 although damaged in the middle, only 2166 concrete remains could show construction, possible basal layer for brick for brick course platform. Although they do appear to be separate platforms. The straight end of bricks facing south do not have mortar remains upon, supporting the idea that they are separate features/platforms
2151	Structure	chimney group 2144	0.58m 0.59m		Chimney within 2150 part of group 2151 external limits are unclear interior apparent constructed from yellow brick, grey mortar in a header stretcher pattern on visible courses within brick floor/platform 2150 although area is separate from machinery anchor area can be seen in western corner of 2150/group 2144 south facing interior of chimney suggests that higher courses had a different brick pattern. Change from stretcher-header
2152	Object	anchor bolt of group 2144	0.83m length 0.04m width		Fe anchor bolt used to hold down machinery upon 2150 used in conjunction with 2153 2154 2156 2157 2158 2159 to brace/hold machinery in place upon brick base 2150. Majority of anchor bolts on the same east western alignment including this example 2159 2158 more northerly but one upon the same alignment. Majority of surviving anchor bolts at southern edge of 2150. Two others at northern edge. The iron anchor itself is angled towards south east. Length of surviving anchor 0.83m 0.04m thick. Other than being cut into 2150 Fe anchor is approximately 0.18m from brick floor layer below.
2153	Object	anchor bolt group 2144	0.55m x 0.05m		Fe anchor bolt used in conjunction with the other examples to held down machinery upon brick base 2150. 6 in a line at the southern edge of brick base. Possibly suggesting more restraint was needed from the southern side.
2154	Object	anchor part of group 2144	0.14m 0.05m		Fe anchor bolt used to hold down machinery in conjunction with 2152 2153 2156 2157 2158 2159 cuts into brick base 2150, which is a brick machinery platform majority of anchors needed on the southern edge of 2150, suggesting more restraint was needed from this side. Very little remaining from this example although the original cut through 2150 is visible, slightly offline with other southern examples.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2155	Object	anchoor bolt of group 2144	0.25m-L 40mm diameter		Fe anchor bolt used to hold up/down machinery upon/within 2150 brick platform part of group 2144.
2156	Object	anchor bolt of 2144	0.6m 40mm diameter		Fe anchor bolt used to hold up/down machinery upon/within 2150 brick platform part of group 2144
2157	Object	Anchor bolt of groupp 2144	length-0.25m 40mm diameter		Fe anchor bolt used to hold up/down machinery upon/within 2150 brick platform part of group 2144
2158	Object	anchor bolt of group 2144	0.45m length 40mm diameter		Fe anchor bolt used to hold up/down machinery upon/within 2150 brick platform part of group 2144
2159	Object	anchor bolt of group 2144	0.25m length 40mm diameter		Fe anchor bolt used to hold down/up machinery upon/within 2150 brick platform part of group 2144.
2160	Object	Fe plate from chute 2162	w=0.47m min L=1.09m <10mm thick		Iron plate within chute 2162 on the south wall of chute, heavily corroded, not fully excavated/revealed, therefore total length unknown
2161	Object	Timber (vibration suppressor)	L=0.5m, w=0.09m x 10cm		Timber vibration suppressor within chute 2162, greatly damaged on the top
2162	Structure	chute in base 2150 group 2144	L=1.38m w==0.53m	0.52-0.62m	Rectangular chute heading downwards towards the north. Contains an iron plate 2160 and timber resting behind the iron 2161. Built in amongst large yellow bricks of 2150 part of group 2144 seems to have contained same fill as 2164.
2163	Deposit	fill between 2150 2129 2146			Maybe same fill as 2164 fill of bay in between walls 2129 2146 2142 2148 2149 and large brick area 2150. Fill contains large amounts of brick and stone and rubble, surrounding walls are made of yellow brick unsure how deep area is.
2164	Deposit	fill between 2148 2150	L=3.82m w=1.84m-2.1m		Rubble fill between 2148 and 2150, contains stone/brick and smaller pieces. Unsure of how deep area would have been. Same rubble may have filled 2162. Maybe same fill as 2163.
2165	Negative feature	cut in group 2144 (void)	L=3.1m w=2.3m	1.56m	Rubble is filled with stone bricks and large amounts of cement/mortar that has been destroyed and fallen in from 2167 2166 2169 2129 2150. Cement mortar is white with small pieces of rubble/brick/stone in. Rubble also contains lime slag
2166	Structure	concrete/brick/lime slag foundation	9.7m=L		Dark grey cement covering lime slag. Iron staining on south corner. Mortar cement floor. Seems to be part of, and underlying 2167. Uneven floor level possibly made so by machine, contains lime mortar, brick, lime slag. May have originally been covered by the yellow bricks in 2167. May have been resting on lime slag pile.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2167	Structure	brick floor 2144	L=6.4m w==5.2m		Brick surface is bonded with dark grey mortar possibly contemporary with 2150. It has been constructed on a pile of lime slag topped with lime mortar to strengthen as can be seen by a section cut made by machine next to 2165. In bad condition with most of the bricks having been destroyed. Because of the destruction of the bricks the dark grey mortar is visible and seems to slope and disappear into 2166. At the highest level 2 courses of brick are visible in patches above the level of 2166. It seems likely that the yellow bricks in 2167 may have extended to cover 2166
2168	Negative feature	pipe line cut through group 2144	0.74m width 13+m length	1.14m	Cut through group 2144 on the west side probably for a modern sewer pipe. Leads from manhole 2034, no evidence of the pipe itself but the cut is substantial. Several other features have been cut by the course of this pipe
2169	Structure	wall part of 2150	0.62m thick opposite 2161 up to 0.95m 2.36m+ long		Yellow firebrick wall English bond construction with hard grey mortar, roughly pointed probably intended to be buried. Forms the southern wall of a probable chimney stack (2161). The top of the wall is covered with modern looking off-white concrete with gravel inclusions bedding for a pipe. On close inspection, the wall is part of 2150 as a single build, no separate phasing for 2169 is visible.
2170	Structure	Masonry at base of wall 2143	2.56m L x unknown width	0.56m	Section of stone making up part of the base of yellow fire brick wall 2143. The stone has been used at the point of intersection of wall 2130 and 2143, although neither wall actually touches. The stones present a rectangular appearance, being fair faced and bonded with un-pointed hard grey mortar, suggesting the length of wall was intended to be buried. The wall is 7 courses high as excavated and appears to be lower than the brick base of the rest of the wall. There is no obvious reason for this section of the wall to be stone.
2171	Negative feature	Trench for wall	0.9m W x 8.65mL		Cut for foundation of wall 2174 filled with large angular stones and a grey sandy grit. Truncated by wall 2207 which is probably later date and 2143 which is earlier and unexcavated.
2172	Group	Four Bay Masonry Structure	19.35m L x 8.65m W	1.5m	Four bays separated by internal walls and with no apparent entrances. Partially excavated not to base. Bay fills are 2194, 2195, 2196 and 2197. Walls are 2176, 2181, 2175, 2177, 2178, 2173, 2174, 2180 and 2179. Also present are square box negative features 2193, 2192, 2191, 2190, 2189, 2188, 2187, 2186, 2185, 2184, 2183 and Fe object 2182.
2173	Structure	Masonry Walling of group 2172	18.25m L x 0.75m W	1.45m	Wall of group 2172. Built butting brick floor____ , of which it is a later addition. Unlike other walls in the group it contains no recess. It was constructed with wall

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					2174 and 2177 with which it is bonded but earlier than 2179 which is butted against 2173.
2174	Structure	Masonry wall of group 2172	8.65m L x 0.6m W	1.5m	Stone wall part of group 2172. Foundation cut is 2171. Only potentially still standing with height changing throughout the structure. Bonded with 2175 and 2173, butted by 2178. Contains recesses 2183 as an iron base.
2175	Structure	Masonry walling of group 2172	1m W x 3.9m L	1.45m	Stone wall part of 2172. Bonded by wall 2174 and butted by 2198. Also butted by later wall 2208. Contains a plinth 1m from base and 17cm protruding. Also contains recess 2185 0.6m from base.
2176	Structure	Masonry walling group 2172	3.9m L x 1m W	1.4m	Stone wall part of 2172. Built together with and bonded with wall 2177. On southern side butted by 2113, which appears to be a later addition. Contains a plinth 1m from the base and 0.2m protrusion. Contains recess 2192 and 2193 0.5m from base.
2177	Structure	Masonry walling of group 2172	8.65m L x 0.65m W	1.4m	Stone wall part of 2172. Built together with and bonded with 2173 and 2176 as well as potentially 2178 although less clear. Contains no recess unlike other walls in this group. N-facing side has height of 2.1m suggesting the base may be deeper than excavated.
2178	Structure	Masonry walling of group 2172	18.25m L x 0.95m W	1.2m	Central wall of 4 bays made of masonry stone. Grey mortar. Two masonry walls 2179 and 2180 bonded at the centre. North most walls bonded to 2177. South most bonded to 2174. Comprised of various sized masonry stones, very large to medium stones northern edge west facing wall face comprises two recesses 2189 and 2190. Southern end. East facing wall of masonry also has recesses 2187, 2186 and 2184. Fe object resting approximately 7cm onto current top course of wall 2182. Mortar is grey in colour with charcoal flecks. Average brick dimensions 19 x 8 x 11cm.
2179	Structure	Masonry walling of group 2172	3.1m L x 0.65m W	1.08m	Masonry divider wall of 2 bays abutting 2178 and 2173. Large to medium masonry stones used for construction not as wide as surrounding walls, 3 courses in width. Faced on either side, both north and south facing walls no recesses in either face. Small damage to some places.
2180	Structure	Masonry walling of group 2172	3.05m L x 0.64m W	1.37m	Dividing masonry wall of two bays. Large to medium stones used in construction width the same as 2179, suggesting inside walls 2-3 courses of stone used in construction recess in wall in north facing face approximately. 1.1m from top of wall 2191.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2181	Structure	Masonry walling of group 2171	9.9m L x 0.79m W	1.31m	Masonry walling between 2175 and 2176 later addition to construction however 2180 overlies suggesting central bay divisions are later addition to a once open area comprised of the 4 main walls 2174, 2173, 2177 and the eastern walls 2175 and 2176 meaning a gap where a entrance/exit due to facing stones being visible upon 2175 2181 abuts 2175. The southern edge west facing side of 2181has staggered masonry sticking out of it which may suggest remnants of a contemporary wall. There is also a plinth that runs the length of the whole 3 construction phases. 2175, 2181, 2176. Approximately 1m in height and 20cm in width. More staggered stones are visible at the northern edge of the wall on the west facing wall face. Possibly once again suggesting a contemporary wall which is no longer detectable. East facing face faced with masonry. Masonry stones are southern edge are contemporary with 2198 appears to fill a gap between 2175 and 2181. 2181 is a later addition as is northern edge with staggered stones appear. (although less obvious) to be contemporary with 2199. Height on eastern face to floor/ current floor level = 1.31m. Western face to current floor level 1.3m.
2182	Object	Iron Rail	3.07m L x 0.05-8m W	0.1m	Iron rail balanced upon current remains of wall 2178 and plinth of wall 2181. Unknown if this is original position although appears to be stable. Appears to have collapsed into situ. Possible iron girder used as support for roofing. Apparent shape visible - see photos.
2183	Negative feature	recess in walling group 2172	0.19m x 0.21m	0.15m	Recess in wall 2174 upon north facing wall. 0.18m from top of wall 0.6m from current floor level.
2184	Negative feature	recess in walling group 2172	w=0.14m	0.11m	Recess in wall 2178 on eastern side located 0.63m from the current top of wall and 0.36m from corner between 2178 and 2174 offset by 0.16m
2185	Negative feature	recess in walling 2172	l=0.41m-0.29m w=0.2m	0.17m	Recess in wall 2175 upon west facing wall in alignment with another recess on wall 2178 although larger and an odd shape (see sketch) 0.5m down from plinth of 2175 0.18m up from current floor level.
2186	Negative feature	recess in wall 2172	0.17m height 0.26m length 0.19m width		Recess in wall 2178 upon east facing wall. 0.17m down to current floor level 0.73m to top remaining course of 2178 it is unclear if this is reflected in wall 2181 due to unexcavated area
2187	Negative feature	recess in wall 2172	w=0.28m	0.17m	Recess in wall 2178 18cm thin wall. located 61cm from remaining top wall 20cm from corner with wall 2180 recess in E face of 2178
2188	Negative feature	recess in wall 2172	w=30cm	14cm	Recess in wall 2173/9??? on N facing side located 52cm from current top wall 18cm from corner between 2179 and 2173 offset by 19cm

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2189	Negative feature	recess in wall 2172	25cm	23cm	Recess in wall 2178 on the west facing side located 53cm from the current top of wall and 43cm from corner between 2178 and 2179 offset 23cm
2190	Negative feature	recess in wall group 2172	170mm deep, 280mm wide, 155mm inset into wall 2178		Rectangular “beam socket" in west facing elevation of wall 2178 In NW chamber, part of 4 walled chamber group 2172. Substantial stones on all four sides of recesses, 2189 is similar in construction. Suggests designed to hold beam firmly in position, perhaps to ??? out vibration
2191	Negative feature	recess in wall group 2172	190mmx105mm inserted 180mm into 2180		Recess beam socket in wall 2180 in N facing elevation
2192	Negative feature	recess in wall group 2172			Beam socket in wall 2173 (s end of). One of three set at some 'level' within NE chamber within group 2172
2193	Negative feature	recess in wall group 2172			Beam slot in wall 2173 part of 2172 group. As with 2192 a beam slot created within west elevation of wall 2173. Construction making use of large sandstone/iron stone blocks
2194	Deposit	fill between bays of 2172			Fill of bay of group 2172 with frequent brick and angular stone, within a sandy grout. Dump layer created in one phase when the bay was abandoned, Not fully excavated
2195	Deposit	fill between bays of 2172			Fill of bay of group 2172 with frequent brick and angular stones within a sandy grit. Dump layer created in one phase when the bay was abandoned not fully excavated
2196	Deposit	fill between bays of 2172			Fill of bay of group 2172 with frequent brick and angular stones within a sandy grit. Dump layer created in one phase when the bay was abandoned not fully excavated
2197	Deposit	fill between bays 2172			Fill of bays of group 2172 with frequent brick and angular stone, within a sandy grit, dump layer created in one phase when the bay was abandoned not fully excavated
2198	Structure	South coal coke bay	37.3m L x 0.67m W		Stone block wall with part of a coke bay. Butted against red brick through 2202. Western end truncated and bonded with 2181, butts 2175. Parallel to 2199, section missing at 19.7m from the west and 23.7m from the W for 2.3m and 1.1m respectively. At 34.1m from the south there is a 0.3m by 0.36m recess. Eastern end not fully excavated.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2199		North Wall Coke Bay	38.9m L x 0.69m TH	1.8m	Extensive masonry wall forming the south elevation of the North Coppée oven battery. Built of largely rectangular, grey sandstone blocks bonded with hard grey coal rich mortar. The wall is a quality build, nicely worked stone, jointing is highly rectangular. Although the coursing is irregular. Red brick trough 2202 adjoins the rear (N) face of the wall. The masonry contains two square recesses in its length. Sandstone blocks vary in size from 0.07m x 0.05m to 0.56m x 0.17m. The upper part of the wall is missing and the lower parts are below the excavation level but it survives to some 15 courses in places. There is no discolouration from coke or coal visible on the stonework, probably as it was exposed to the elements. No evidence of any of the stone being re-used from earlier structure i.e. the mortar stains. On examination of a photograph provided by Alan George , the square recess are likely to be to retain the upper part of the bulkhead assemblies for the different components in the coke bins.
2200	Deposit	Fill in coke bay			General demolition layer forming the fill between the two batteries of coke ovens in the area shown as coke bins on OS mapping. The deposit consists of a variety of refractory brick, red brick, stone blocks, shale, slag and small iron fragments/objects like pins and washers. This is almost certainly the general demolition left as a result of destruction of the coke ovens. Depth is unknown.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2201	Structure	Red brick trough - south	0.51m base width, 1.1m overall width, 32.5m L as e	1.09m external height, 0.5m internal height max	Red brick built trough, adjoining masonry wall 2198 and running parallel to it. The wall is bonded with hard grey gritty mortar with the brick being machine made and displaying circular mould marks which are different to those seen in the brick for trough 2202. The south wall of the trough is 0.48m wide surviving to 9 courses maximum. The internal face contains 8 square recesses, measuring 60mm x 55mm most of which are damaged and iron stained. These recesses are found at 0.31m from the base at the west to 0.42m from the base towards the east reflecting the fall in the trough line in this direction. The base is constructed from bricks laid flat but is not bonded into either wall. The north wall of the trough is a single skin of brick, much damaged towards the eastern extent. The floor of the trough cants to the south at its easternmost extent, creating a build-up and possibly indicating slumping during its operational life. The external flue (southern) of the trough is much better finished than trough 2202 with neater pointer evident. English bond construction for much of its height but the pattern changes at the upper and lower portions. The wall steps out to the south for 3 courses before stepping in again - this is different to that employed in 2202. The trough has been cut by the course of a modern pipe trench. IMPRESSION: This trench is almost certainly a housing for a high pressure hose pipe for quenching the coke as it comes out of the ovens. There is no evidence for it being a drain i.e. No silting etc. It is virtually a minor copy of the trough to the north (2202) although the built quality and bricks are superior. The trough is more damaged than 2002 but its form and function can still be discussed. A section of rusted iron pipe is still attached to masonry wall 2199 which is probably the remains of a water pipe Feeding into the trough from the south. The recess for holding the water pipe are mirrored by iron stains on the opposite wall though there is no evidence of recesses. Rather it suggests something iron against the bricks.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2202	Structure	Red brick trough - North	38.9m L as exposed, 0.53m Channel, 1.02m overall	0.63m Depth	Trough/channel built of red brick bonded with hard, grey, gritty mortar, built adjoining masonry wall 2199, which is immediately south and running parallel to it. The bricks are machine made each having two or more circular mould marks running down the centre. The south elevation of the trough is a single skin of bricks abutting masonry wall 2199. The northern elevation is more substantial, being 0.34m wide with an external elevation 1.35m high as exposed. The base of the north elevation is stepped inwards reducing thickness and the pointing is roughly finished suggesting it was intended to be buried. The inside elevation has a number of broadly square recesses measuring an average of 55mm x 50mm and a depth of 60mm - 70mm. These recesses are irregularly spaced down the exposed length of the wall and do not occur in the opposite side of the trough. Each recess is iron stained and would appear to be recessed in order to retain iron pins, probably to support a high pressure water pipe. There are 22 recesses in the exposed length and are located 0.25m from the trough base at the west, rising to 0.48m above the base at the east extent. The base of the trough cants towards the north the further east it extends probably where the supporting ground has settled and caused it to slump. The angled base has caused a build-up of iron rich residue against the north wall of the trough, indicating the trough had probably slumped during the its operational life. This residue is only present in 12m of the easternmost part of the exposed trough, where the slumping is worst. The trough has been cut 17.54m from the western end by the course of a modern pipe trench. There is a brick step, 3 courses high at the far western end, the top of which shows evidence of iron staining? To support the start of a high pressure water pipe. Individual bricks appear to be of the same type, each measuring 0.22m x 0.1m x 0.075m though these are individual variations in dimensions. There appears to be a fall in the trough base towards the east of the structure. This trough is in a better state of preservation than trough 2201, which is almost identical in form and construction. IMPRESSION: This trough almost certainly housed the high pressure water hose providing water to cool down the coke on the benches above, the hose bay retained in place by metal clamps/pins set into the north wall. There is no evidence to suggest that the trough itself was a drain i.e. No silting, no clay lining etc. The recesses for supporting the pipes are mirrored by iron staining on the opposite wall but there is no evidence for further recesses - rather something iron resting against the wall.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2203	Structure	Stone capped drain	5.4m L x 1.25m W	0.25m	Linear stone capped drain facing NE. North end of drain has been caved in with extra rubble blocking drain. Wall has fallen in. Stone caps remain on top on east side. The drain meets culvert. East end has large rubble/stone on top. Spots of iron and natural clay spotted along the length. The drain was excavated further and it was found that more yellow bricks and stones lead slightly away from this drain to the north slightly and it seems to have been a second drain/channel. A large hole was dug going through the middle but only one channel could be seen so it seems the second smaller channel disappears towards the middle.
2204	Negative feature	Recess in face of wall 2127	0.33m x 0.29m	0.13m	Irregular shaped recess within brick wall 2127, probably originally a diamond shape found by an irregular arrangement of bricks. Was almost certainly a recess to accept a timber beam, one of which lies towards the bottom of the chute (2063). The interior of the recess is formed of badly laid red bricks, distinct from the yellow engineering bricks that are used elsewhere in the wall. No evidence of timber remains in the recess but grey mortar is present that may have helped hold a beam. The recess appears to be a later insertion interior wall 2127 on the yellow refractory bricks of that structure have been removed and the damage patched with red brick. It is possible this reflected two phases of the same function, with the faint iron stain of 2206 relating to the first phase, with iron stain 2205 relating to the Phase 2.
2205	Deposit	Iron staining	2.94m L x 0.03m Thick		Linear iron stain seen on brick wall 2127. The stain follows the profile of brick chute 2063 and probably marks the location of iron plates held above the chute by being affixed to a timber beam retained in recess 2204. There is evidence of rivets or bolts on the iron sheeting as in two locations, the stain includes circular patterns. Forms the uppermost stain of two the other being 2206).
2206	Deposit	Iron Staining	2.7m L (0.02-0.01mL)		Linear iron stain seen on brick wall 2127. The stain follows the profile of brick chute 2063. A similar but far more prominent stain (2205) is located above this stain. It is unclear whether 2206 also marks the position of iron plates, but it is probably related in function. 2206 becomes indistinct the lower it goes disappearing after recess 2204.
2207	Structure	Masonry wall	8.78m L x 0.9mW	0.75 - 1.3m	Faces east. Grey mortar. Large masonry wall made with stone. Joined to the red brick of 2208. Wall is lost slightly as 2201 is built onto it. There is a 0.13m ledge along the bottom of the wall. 0.58m up another ledge starts 0.15-0.19m wide then there is the remains of the top. The top section is lost just before 2174 and 2175. Some of the second ledge has been lost to the south where the wall connects to 2209.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2208	Structure	Red brick face on wall 2207	8.8m L x 0.1-0.22m W	0.56m - 1.13m	West facing. Gives a smooth face to 2207. Made with an alternating header and stretcher pattern 2208 and 2207 seems to have been built before 2175 and 2174. The brick disappears under mortar, an iron pipe and collapsed stone of 2175. Grey mortar wall face is flat.
2209		Brick pier south of wall 2207.	1.52m L x 1.26m W	0.85m - 1.12m	Made from yellow and red brick mortar is the same as the mortar in 2208 and 2207 and 2211 and 2210. All that remains is an odd shape that seems almost square with the bricks coming away in a slope. A frogged brick stamped with EBBW VALE is visible on the south side. It seems likely that the wall would turn at a right angle to head east as a brick is just visible through the soil as the bricks disappear. It also seems likely the wall may continue heading south as 2208 does not seem to stop. It is not possible to find out right now if the wall does carry on east and south as this would mean going below the formation level. It also appears that half of the wall seems to be divided by two different types of brick; red brick on the west side and yellow on the east side. These yellow bricks also seem to be the same as those used in 2211 and 2210. Some red brick have been used on the top of the east side.
2210	Structure	brick and masonry walling part of 2211	L=3.74m w=0.74m	1.07m	This wall is resting on clay and rubble yellow brick has then been built on it for 3-4 courses in an alternating stretcher header pattern and then built up with stone and is in good condition on the west face. The east face seems to have been built using just brick is 10 courses still surviving on the northern edge on the header stretcher pattern. Not much of the east face survives towards the south. One course is visible and these have fallen due to the soft rubble fill underneath. The bricks on the western face are visible. The grey mortar is similar to that of 2211 2209 2208 2207. The right angle where 2211 meets and creates 2210 on the west face has used bricks to make the turn then carried on using bricks for the bottom 3 courses then changed to stone on the top although there are still some bricks existing on the corner turn. It seems 2210 2211 are built at the same time due to the bricks on the inner and outer corner being built into each other
2211	Structure	Walling (part of 2210)	L=1.66m W=0.48m	0.5m	Red brick wall east-west orientation abuts 2208 contemporary with brick wall 2210 due to apparent bonding. South facing wall illustrates clear abutting to 2208 and demonstrates a plinth coming off the walling itself. Alternating brick bonding with later grey mortar which has charcoal flecks in it. There is a change in bonding where the plinth of bricks attaches to the wall interior 2 courses of stretchers as can be seen below (sketch) Some damage is visible, evident that the height is not original as

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					some brick courses remain. Underneath the 7 visible courses of north facing wall appears a fill of rubble, small pebbles. It is made of rubbish does not seem stable foundations for wall.
2212	Structure	brick flooring	L=0.91m w=0.28m-0.21m	0.09m	Remains of brick flooring within walls 2209 2210 2211 consists mostly of yellow brick with 1 red brick (red brick is 23x11x7.5) yellow brick is 21x10x6cm The floor is one course of brick with a layer of mortar securing it to the underlying fill. Additionally the floor slopes down towards the west
2213	Structure	masonry walling	L=12.25m		Stone masonry walling running n-s along the western edge of bays constructed from walls 2217 2218 2214 and floor 2219. The wall is bonded with 2173 and brick quoins from wall 2214. The total height of the wall is unknown due to the top being damaged and the wall not being completely revealed at the base. The stones making up the wall are a mix of large rectangular stones and thin long stones similar to flagstones. The wall also cuts through earlier wall 2250 2249 on the west side. The wall is also noticeably wider than the other stone masonry walls on either side.
2214	Structure	brick walling	L=7m W=0.47m	0.26m	Red brick wall between 2 brick floors numbered 2221 2220 and 2219. Some damage to wall remains. Two courses remaining. Alternating header and stretcher bond.
2215	Structure	brick walling	L=8.2m	2.33m 28 courses	Red brick 28 courses high 2 courses of yellow brick of 2227 comes into the top of the wall., sits behind wall 2315 and fill 2313.
2216	Structure	brick walling	l=1.56m w=1m	0.89m	Red brick walling, grey mortar, The majority of the 11 courses are alternating header and stretcher although where 2216 adjoins 2230 There is a variation in brick patterns at the eastern edge of bricks (second course has a stone adjoined to 2230 8th course shows a header 4 stretchers then another header. Mortar of 2230 appears to be lighter than the mortar of 2216 6th 7th 8th courses are mainly stretchers. This contains fill 2213 in the southern edge of fill. It appears to be later than masonry wall 2230 as from birds eye view a clear cut is visible in 2230 to accommodate 2216.
2217	Structure	red brick bay wall	L=6.05m W=0.46m	0.65-2.1m	Red brick wall dividing and creating two bays 25courses high in an alternating stretcher and header pattern.
2218	Structure	red brick bay wall	L=7m W=0.47m	2.3m	Red brick wall of bay from north looking onto the north facing wall only 2 courses are visible with 3 on south edge south facing a number of courses are visible approximately 25 courses 2 courses thick. Abuts 2213 as does 2217.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2219	Structure	Brick floor	L=6m W=2.16m		Yellow brick floor with bricks worn away towards the west side (by machine?) Discolouration on bricks possibly due to iron rusting. Bricks have been raised to a higher level around the edges of the walls 2213 2218 2214 in comparison to the rest of the floor which has uneven levels throughout possibly due to the fill underneath sinking. The mortar is a dark grey which suggests this is a later stage of the works compared to other area. The main pattern of the bricks seem to be a stretcher pattern with stretcher bricks lining the edges although the western edge lining wall 2213 seems to be header pattern. Along the north edge of the floor along 2214 there are cuts in the floor where bricks have come away revealing the fill. On the west the cut 2311 is 83cm away from wall 2213 and is 90cm long and 36cm at its widest along 2214. The fill inside 2312 is visible and still has iron remains in it. Another cut further down is 1.9m long where one course of stretcher bricks have been removed (11cm wide). An extra 3(?) bricks may have been moved at the top of this cut making the widest width 30cm. Towards the east end nearest 2227 lies a large intrusive cut 2406 1.44mx 1.17m also revealing a fill 2407. This fill may be similar to the fill of 2312 but is difficult to know for certain occasional red brick placed among the yellow brick.
2220	Structure	Brick floor	3.12m L x 1.92m W		Brick floor butted against wall 2214. Continues under wall 2229 and re-emerges as floor 2221. On South side course of bricks parallel to wall and on W side a course of larger brick, 0.35m x 0.35m butted against wall 2224 floor would have originally continued up to wall 2225 but it is cut by 2228 floor made of a simple course brick on a black mortar fill.
2221	Structure	Brick Floor	2.3m L x 1.13m - 1.83m W		Same layout as 2219. Yellow brick in stretcher pattern. Slightly uneven level on south edge. Grey mortar. Bricks on north side have been lost showing fill. One stone has been placed down instead of bricks. Flooring is broken so fill of 2228 is visible on the north side.
2222	Deposit	Fill between bay 2218 and 2217	6m L x 3.8m W	2.3m	Dump layer within bay of 2218, 2217. Deposited in a single phase when bay was abandoned probably intentionally.
2223	Deposit	Fill between bay 2217/2177			Orangey/brown rubble rich fill sandy loam texture. Rubble include large stones and medium stones, frequent small stones and bricks which are damaged same fill as 2222 not 100% excavated to the true floor level. Only partially excavated.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2224	Structure	Part brick - part stone wall	3.3m L x 0.7m W	1.22m	Brick wall with stone facing on W side. Clear cut on W side between stone faced stone wall 2213. Butted by later brick 2220. Cut by void 228, where only 0.7m remain. Bonded with wall 2225. Facing appears to be contemporary to brick part due to lack of brick face that side.
2225	Structure	Brick Wall	7.7m L x 0.75m W	1.25m	Brick wall, bonded with 2224, contains 1.25 box cut which extends entire width. An additional row of bricks added on south side of box to top of wall. Floor 2220, 2221 and wall 2229 probably butted walls originally but has been cut by void 2228. Butted by 2238, 2226 and 2231. Box cut begins 0.7m from base.
2226		Walling	3.08m L	2.1m	Yellow brick walling infill of an opening between redbrick wall 2225 and 2227. 25 courses. Alternating header and stretcher bonding. Later than 2225 and 2227 infilled the void between them. Clear division no bonding the small recess in southern most end.
2227	Structure	Walling	2.14m L x 0.71m W	0.12 - 0.23m	Grey crumbling mortar. Yellow brick same as brick door 2219. Cuts interior and butts up against 2214 and 2218. 3 courses of brick sit on 2215 so it seems to be built later. Could be contemporary with 2217. The face is laid out in a header - stretcher pattern. Looking down over the top there are four rows making the wall.
2228	Negative feature	Pipe line cut walls 2224 and 2226	7.7m L x 1.1m W	1.3m	Cut for pipe line cutting through walls 2224 and 2226, although some of the walling remains. It also cuts through floors 2220, 2221 and wall 2229. Filled with rubble fill much of bricks with grit. Butted against wall 2225.
2229	Structure	Masonry walling	1.7m L x 0.95m W	0.28m	Stone walling overlying brick floors 2220 and 2221. Butted against 2214 cut by ditch 2228.
2230		Masonry Walling	7.73m L x 1.4m W	1.35 - 2.15m	Masonry wall large stones used for construction. Evidence of adaption to the wall at the southern end appeared to be a step/stairs which have been filled in at a later date. Later grey mortar from above it is apparent that 2230 has been cut by 2216 the northern end showing steps/filled in steps of wall. 2230 abuts 2176 due to possibly facing on the east facing wall of 2176. Variation in height measurements from east wall face 1.15m to west facing wall of 2130 due to variation in the floor level/limit of excavation. It is not the true floor level on either side so is not a true representation of walls actual height.
2231	Structure	Brick base	2.6m L x 2m W		Brick base containing chimney 2232. Unexcavated due to asbestos. Later than containing walls 2235 probably used to level area. On north side slopes down in a series of steps although its possible this is only due to the collapse of part of the base.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2232	Negative feature	Chimney	1.2m L x 1m W		Chimney within floor 2231 filled with sandy grit, small angular stones and bricks. Not excavated due to presence of asbestos. Insulation nearby suggests high temperatures would have been present when active. Also butted against wall 2328.
2233	Structure	Honeycomb brick	1.7m L x 1.2m W	1.2m	Structure composed of a number of steps on the west side with honeycomb mechanism on the east side. Honeycomb structure associated with chimney 2232, used to facilitate movements of air. It is built together and bonded with floor 2231. Design of honeycomb structure on back.
2234	Object	Iron lintel supporting 2233	1.7m L x 0.15m W		Iron lintel at base of brick stepped 'honeycomb' structure. 2233 between walls 2323, 2235, 2326
2235	Structure	Brick Wall	4.5m L x 0.38m W	1.64m	Brick wall alternating heading, stretcher bonding overlies early coke oven flooring 2235. 18 courses surviving cannot tell a clear relationship with 2225 although appears to butt against.
2236	Structure	Brick Wall	2.46m L x 0.33m W	1.41m	Red brick wall bonded with wall 2235 and 2237. Overlying floors 2244 and 2246. The wall has been damaged along the west end and the top. The bricks measure 220mm x 110mm x 75mm and bonded with light grey mortar. The wall was not completely revealed due to the presence of asbestos in the area.
2237	Structure	brick pier	0.23m=w 0.36m=l	1.23m	Red brick pier coming off 2236. Small division with 2 courses surviving. Overlying earlier coke oven floor 2244 and a hard dark grey layer which may be a later floor/levelling for walls.
2238	Structure	brick wall	L=2.4m w=0.35m	0.52m surviving	Length of red brick walling, damaged true height unknown, depth unknown. At least 8 courses of brick (230mmx110mm75mm) alternate headers and stretchers courses (English bond) with hard grey coloured mortar with lime flecks, shale-stone flecks and coal flecks. Possibly linked to 2236 to create a rectangular bay.
2239	Structure	brick wall	w-0.87m l-0.48m	0.78m	Remains of brick wall running alongside wall 2225. Bonded with the S end of the west wall 2235. The wall was not fully excavated due to the presence of asbestos. The wall was constructed with yellow bricks (22x11x8) and bonded with light grey mortar with charcoal flecks

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2240	Structure	brick wall	l=3.3m w=0.6-0.25m	0.48-0.78m	A NE/SW running linear wall overlying the stone built wall 2245. The wall is brick formed bonded by a dark grey mortar with some charcoal flecks. The bricks were yellow in colour and one brick had a stamp King brothers Stourbridge. The brick built wall can be seen overlying the e-w running wall towards the central of the all 2240 whilst either side of 2245 it has been built upon the fill 2000. It features between 4 and 5 courses and abuts 2225 (wall). The bricks also vary in size the smaller being 0.1x0.15, the larger being refractory bricks. South side of wall damaged possible original width 0.6m. Height variable top lost due to truncation surviving at 0.78m to the east against 2225 to the west 0.48m. The top is truncated fairly level, base of wall made to fit surviving earlier structure 2243- not a level plane. Structure late built over fill-coal rich with ? Shale and occasional large stone. Lower courses (5-6 in total) using ??? Brick of all sizes to form the foundation then a mix of header and stretchers used to carry the wall upwards. Irregular coursing possible because of bricks to hand and not new bricks. All bricks show signs of wear. Wall cracked where it overlies earlier structure 2243. Recess built into wall on east side (0.4 deep 0.25 wide 0.7 height) built up using large refractory bricks, unknown whether recess originally blind or open topped. Probably blind.
2241	Structure	engine base	3.3m x 1.7m	1.2m	Structure comprised of reused yellow brick and fragments of brick and stone to form a rectangular base. Bricks of all sizes similar to 2242. The surface of the base has squared sockets to hold anchor bars presumably for machinery. Three bars surviving in 6 recesses. Small recess may be false. Recess crudely formed with brick and stone roughly square to rectangular orientated N/s three each side in pairs. Whole base probably built in trench cut through coal and shale debris a general accumulation of that built up on site. The exterior elevations are poorly finished with mortar lumps prominent on the exterior. No attempt to create a flush face with the brick/stone. Presumably the anchor bolt originally central to the structure whose edges are damaged. This structure extends south for 0.9m to incorporate 2242.
2242	Structure	brick base	1.15m E/W 0.93m N/S	1.1m	Rectangular brick platform/base built onto the plinth of base 2241. Constructed of irregular sized bricks to a stretcher bond. The exterior elevation not well finished with mortar oozing out Probably built in a trench, the elevations not to be on view 15 courses surviving, the lower 3 regular red brick to form the foundation red brick (230x110x75mm) irregular brick 110x50mm reused brick for upper 0.75m

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2243	Structure	Masonry, oven outer walling	L=3m n-s 1.15m width	1.7m	Exterior wall of earlier ovens comprised of large square limestone blocks built to courses surviving corner similar stone but stressed quoins hammer dressed on quoins. Batter on west side flush on north side. Constructed on a foundation course of 2 courses of brick laid as headers with hard a grey mortar with coal flecks and lime flecks/lumps. Overlying the foundation brick are limestone keyed on to at least 0.4m up. Therefore probably limestone only, interior floor level not determined. Fair face only on exterior elevations inner face against fire brick irregular not perfectly flush. Rubble core behind face of large undressed limestone blocks. Soft light greyish white mortar with coal flecks deposited en masse in the core reflecting the size of voids behind stone. Exterior floor comprised of irregular rectangular shaped stone bonded with hard grey mortar, surface fairly horizontal laid but irregular, stops at corner no face to the east. Fe fitting appear to be centrally placed in line with brick divisions separating the coke ovens. Fe starts at 1,45m in form corner and at the course immediately above foundation level courses. There is a clear division between the walling and the interior firebricks which possibly had to be replaces from time to time. Vitrification up to 0.1m in the joints and about 60mm into the brick although the whole of the bricks are heat damaged
2244	Structure	oven floor	3m=l 1.76=w	0.07m	Brick floor underlying 2235 2236 2237 with adjoining brickwork, possibly ovens dividing wall on far side 2245
2245	Structure	oven brick work	Length 1.76m width 0.85m	0.26m	Brickwork parallel to and adjoining oven floor 2244, some alignment to welsh ovens possible continuation. Brickwork 2426 on SW side butting or abutted by unable to say which is earlier but same alignment 2416 underlies wall 2238 which suggests 2245 is also earlier.
2246	Structure	oven floor	1.4m=l 1m=w		Oven floor found adjacent to 2236 and next to floor 2244. Badly preserved but continuation of floor 2244 interrupted by wall 2236 red brick however suggests it may be different section
2247	Structure	yellow brick to oven	1.4m L 0.6m W		Yellow brick floor of oven associated with floor 2246. Badly preserved with both ends truncated lack of continuation on the NW side suggests may be the edge of the ovens
2248	Structure	Box drain	3.92m L x 0.9m W	0.2m	Box drain cut into natural and possibly cut by wall. Exact relationship is unknown as drain stops on from the wall itself, but may be due to later destruction. Stones vary from 0.12 x 0.10m to 0.5mx0.5m within the drain is a black gritty sand fill.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2249	Structure	Masonry wall	3.2mL x 0.35mW	0.1m - 0.6m	Stone wall butted against wall 2250. Belongs to earlier phase of iron works and is on a different alignment than the modern walls. Is cut by wall 2213.
2250	Structure	Masonry wall	1.16m L x 0.85mW	0.74m	Earlier stone masonry wall adjoining 2249. Bonded with a light grey mortar. Cut by later wall 2213 constructed with large rectangular stone. Only the North east face is visible. The wall is revealed at the same level as the natural.
2251	Group	Canal and culvert			Channel cut arcing from east around to the north. Two side walls erected to form edges of a canal. No stone base but natural clay as the base. At some stage a yellow brick culvert erected within the line of the canal. Voids between the canal wall and the outer curve of the culvert is filled with deliberately placed stone and clay. Surface of culvert is capped with stone as a protection.
2252	Structure	Brick floor of group 2051			Brick floor of 2051. Has 3 iron rails running the length of the floor and 6 timber sleepers 2112-2117 at 1.8m intervals. Patches of iron staining throughout. The area N of 2117 is sloped downward to run into tank 2049 and is made up of different bricks to the rest of the floor. The south end is cut by modern cut 2062. The area south of cut 2062 is lower than the rest of the floor. There is also damage to the floor resulting in slight holes.
2253	Group	Box drain feature, intercepts culvert 2005			Group number for 2nd phase box drain within canal/culvert (Group No 2251).
2254	Negative feature	Recess	0.25m W x 0.4m D	0.3m H	Recess in wall 2240, near its eastern end and wall 2225. Part of the original build into the wall. Base of wall/recess uses existing structure 2243. Brick used is selected from a variety of mixed sizes to form recess. Unknown whether originally 'blind' 0.4m recess but likely.
2255	Deposit	Coal infilling/deposition		1.2m	Build-up of coal and shale covering this part of the site probably from operation of the coke ovens. No clay in the deposit. Adjacent to the oven 2243 and base 2241. The lower 0.6m contains broken yellow coloured brick randomly dispersed within the matrix. Wall 2240 overlay 2255 but uncertain if 2240 later than 2255.
2256		Stone capping for box drain 2253	0.65-0.78m W x 2.5m L (as excavated)		Rough dressed flat stone capping for 2nd phase box drain which intercepts culvert 2005 within canal/culvert group 2251. In part damaged by machine. Slabs vary between 80-130mm thick. Mortar light grey, soft lime with coal fragments.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2257	Structure	East wall of box drain 2253			Yellow brick and lime mortared side wall (east) for box drain 2253. Occasional stone, mainly at intercept where depth increases, requiring deeper stone 'spacers' to spread the coursing out approximately 100mm deeper than main run of the drain. See sketch rear of 2258.
2258	Structure	West wall, box drain 2253			Yellow brick and stone and lime mortared wall (west side) of box drain 2253. Dressed flat faced sandstone and reused full and half yellow fire brick. Evidence of vitrification on some of the yellow brick. Unfrogged brick 210x120x70mm. Stone used at north end where drain fall increases close to intercept with culvert.
2259	Structure	N terminus wall. Drain 2253			Stone and brick frame/terminus wall at north limit of drain 2253, where 2253 intercepts culvert 2005. Brick element appears to be part of culvert 2005.
2260	Structure	Cobble/brick base for drain 2253.	260mm wide. Full length unknown		Crude cobble stone and brick base for 2253.
2261	Group	Feeder drain into canal on wall 2004			Stone and lime mortared box drain. Feeds into canal. Pre-dates culvert 2005. Appears redundant/blocked as no water noted running through it in heavy rain. (Unlike 2253 which still carries water into later culvert phase). Associated with projecting. L-shaped walls 2263/65. General Note - This feature and the narrowing curving of wall 2004 suggesting possible entrance to lock.
2262	Structure	Capping/Exit of Drain 2261	0.82m L x 0.38m W (as excavated)	0.29m	Stone and lime mortared upper framing of box drain 2261. Large single rectangular lintel stone forms upper 'frame' of box drain exit. 3 courses of stone work surviving. Lime mortar on upper surface of top course indicates further courses above at least. Bonded with N-S element 2263.
2263	Structure	East Wall of Drain 2261	1.36m L x 0.68m		Stone and lime mortared east side wall from exit point of box drain, to open air outflow lip over wall 2004 into canal. Opposite west side formed by poured (shuttered?). Iron slag. 2263 and 2265 appears to be the same feature i.e. W and N facing elevation of the same wall.
2264	Structure	Lip, out flow over wall 2004. Part of 2261	0.46m L x 0.2m W	0.12m	Stone and lime mortared lip/ outflow point. Projects beyond main enclosed portion of the box drain 2261. Open air section defined by iron slag wall 2266 and stone/lime mortared wall 2263.
2265	Structure	wall	0.84m W	0.36m	Stone and lime mortared walling appears to be part of the same build as 2263. Either contemporary with build of 2004 or earlier modification of this section of 2004. Perhaps linked to iron slag pour on west side of drain 2261. Feature causes slight narrowing of canal at this point.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2266	Structure	Iron slag slope	0.5m W x 3.12m L		Sloping deposit of in-situ poured iron slag. Appears to create area over wall 2004, west of drain 2261.
2267	Deposit	Compacted coal waste 'working surface'	Depth unknown not bottomed		Compacted coal waste, temporary working surface on south side of possible bonding slope south side of canal.
2268	Negative feature	Pipe trench	>4m L x 0.7m W	>1m	Pipe trench probably connected with the Thorn works. Cuts across earlier coking ovens structures. Similar to 2274/2270.
2269	Object	Pipe	0.28m external diameter, 0.23m internal diameter		11" brown glazed ceramic drainage pipe internal diameter 9". Sectional lengths (length unknown/butted together and encased in concrete up to 0.2m wide.
2270	Negative feature	Modern pipeline	10.8m L x 0.47-1.16m W	Min 0.52m	Modern pipeline cut going through 2288 and 2011 and 2141. Total length unknown as start and end point cannot be identified. Also cuts through 2271 and 2272. Total depth is unknown due to damage to the upper parts of the walls.
2271	Structure	Brick base	4.48m L x 2.3-2.8m W	Min 0.48m	Tiered floor base made up of yellow bricks measuring 0.23m x 0.105m x 0.075m. 3 tiers revealed each consisting of 2 layers of brick, total height of 1 layer is 170mm. 2271 and 2272 are probably part of the same base but have been cut by 2270.
2272	Structure	Brick base	4.3m L x 1.06-1.56m W	0.65m	Construction same as 2271 possibly same base and cut into 2 by cut 2270.
2273	Object	Modern pipeline	18.88m L x 0.5m W		Modern pipeline running east-west sealed in concrete containing bricks and rubble. Contains clay pipe which is partially visible.
2274	Negative feature	Pipe trench	>3m L x 0.6m W	0.5m	Pipe trench probably for the Thorn works. Cuts through coking ovens/flues of the earlier works.
2275	Object	Pipe			Brown glazed ceramic pipe. Interior diameter 9" external diameter 11". In lengths of 0.9m (3Ft) Possibly connected to cut 2270 and its pipe.
2276	Deposit	Infilling west of 2009	1.96m L x 1.18m W	0.8m	Rubble fill consisting of flag stones, bricks and mixed silt and clay. Also contains a moderate amount of charcoal throughout. The West end appears to be fired to a red colour, possibly a result of being next to the flue wall.
2277	Structure	Floor remaining	3.5M L x 0.17-1.16m W		Remains of floor. Severely damaged. Appears to be made up of mortar with small flecks of charcoal.
2278	Structure	Brick wall/floor	2m L x 0.25-0.84m W		1 layer of brick (230mm x 110m x 70mm) and bonded with dark grey mortar with flecks of charcoal. Mixture of pink and yellow bricks. Severely damaged - unable to determine the original shape. Possibly part of 2279.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2279	Structure	Brick channel	Measured sketch on sheet		Possibly same feature as 2278. Comprises 2 lengths of wall and flooring. Measured sketch on back. Between walls various deposits of silty clay but not over the walls. Coursing of the walls seems very irregular as does the layering of the floor.
2280	Structure	Brick divide in flue	1.76m L x 0.37m W	0.56m	Divider wall in middle of 'T' junction coming off South side of flue 2012. Severely damaged made up of yellow bricks measuring 260x120x90mm. Bonded with grey mortar. The wall is severely damaged.
2281	Structure	Brick divider curved stop in flue	4.98m L min x 0.38m W		A dividing wall in the middle of the 'T' junction coming from the South side of the flue. Constructed with mortar blocks with small pebble inclusions and bonded with mortar with sand inclusions. Cut by modern pipeline, therefore total length unknown. Also damage to the top of the wall so total height is unknown. The North end is curved and bonded with wall 2280. Patches of heat damaged along both faces of the wall, but it is more evident on the bottom of the faces. The south end of the wall was not fully exposed due to the presence of asbestos. The blocks measure 370x235x100mm.
2282	Negative feature	Cut for Man Hole 2139	4.34m L x 0.65m W	0.67m	Modern cut for manhole and modern pipeline 2273. Cuts through 2291 and 2290.
2283	Structure	Walling W of flue 2012 T-junction	6.49m L x 0.35m W	0.56m	Wall on the west side of the flue. Cut by 2268 at the south end and joins with 2011 at the N end, but the point at which the join is not discernible.
2284	Structure	Walling E of flue 2012 T-junction	6.65m L x 0.38m W	0.56m	Wall in the east edge of the T-junction running off the south side of the flue. Constructed with bricks measuring 230x110x60mm. The wall was cut by 2268 on the south end and bonds with 2011 on the N end. There is damage to the N end.
2285	Structure	Bricks Wall Part of 2138	0.69m W x 0.46m x 5.6m		A brick wall/floor formed from red bricks and a grey/light/cream mortar with charcoal flecks. Bonded to the N-S running wall 2283 on 2285 eastern side. The bricks are both header and stretcher lain and possibly up to five courses can be seen. It is also bonded to the southern wall of 2011. Towards the centre of the wall the bricks have a rusted colour and there seems to be a yellow mortar staining it. At the centre there are only between 1 or 2 courses visible.
2286	Structure	Brick wall part of group 2138	5.58m L x 0.7m W	0.85m H	A brick (yellow) formed wall, forming as the east-outermost wall of the group 2138. Seen as 10 courses in height. Both stretcher and header lain bonded by a light yellow mortar. The bottom 3-4 courses are bonded by a light grey mortar with charcoal flecks. Cut by the modern pipe2269 and bonded with 2284.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2287	Structure	Wall	0.7m W		Possible continuation of 2286 on the south side. Due to large presence of asbestos it has been left unexcavated.
2288	Structure	Brick Walling Flue			An east-west running wall, yellow bride formed, bonded by a light yellow mortar. Approximately 9 courses in height and the bricks are both header and stretcher lain. The wall has been truncated twice by two modern pipes 2270 and 2274, the context for the surviving eastern pipe is 2275. Bonded with 2285 and 2278. The eastern most part of the wall is butted by the floor remains 2277. The average size for the bricks are 0.23m x 0.1m x 0.08m.
2289	Structure	Brick walling	2.1m L x 0.59m W x 0.36m D		A light grey mortar and red brick bonded wall. The red bricks on average measure 0.21m x 0.1m x 0.08m. Seen as 4 courses in depth and bonded with possibly 2271 seen in profile as following the courses formed by 2271.
2290	Deposit	Brick and rubble filling	0.64m W (between the walls) x 8.83m L x 0.9m H		A brick and rubble, silty industrial fill seen between the northern flue wall 2011 and the brick wall 2291. It contains red/yellow bricks and stones - some flecks of mortar can be seen and other demolition materials.
2291	Structure	Brick Wall	9.75m L x 0.33m W x 0.92m H		Red brick wall, two bricks in width. Pink/grey mortar alternating bricks for construction. Brick dimensions 230x110x70mm. Min height 9cm max height 92cm. Some yellow bricks used around eastern end of wall possible rebuild due to mortar change although could be stained from later works eg 2282.
2292	Structure	Base of box drain	1.1m L x 0.46m W x 0.02m D		Series of thin (20mm thickness) slabs butted together likely forming the surviving remains of a box drain. The basal stones are about 0.46m wide but the central part of the 'box' is indicated by staining and is 0.15m wide, placed centrally on the larger base slabs laid on existing coal rich clays over the cut of the canal and leading probably to the culvert 2005. This is not unusual as there are other culverts leading to the main culvert all entering from the uphill side, to the west.
2293	Negative feature	Void between walls 2011 and 2009	2.6m L x 0.73m W x 0.6m H		Void between walls 2011 and 2009 filled with sandy grit rubble and apparently cut into 2010. Only partially excavated. Eastern side continues under rubble heap 2134.
2294	Negative feature	Trench for wall 2133	Length 11.5m, width 0.6m		Foundation trench for wall 2133, filled with reddish brown sand with some angular stones. It does not continue all the way underneath the wall but stops before the western end. Eastern end interrupted by spoil.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2295	Group	Culvert feature in Area 4	See drawing 18		Stone and lime mortared box culvert with low shallow arch. Feature sealed by orange brick clay. Feature cut into coal deposit 2306. Contains three fills. Unclear if this featured remained active, part construction of the Coppée ovens. Would require pipe to bridge between two coke loading area walls if they do indeed continue well below current formation working level; not yet proved. A Victorian/Edwardian culvert to west of this feature has apparently been constructed through the coke quenching bench, on a N-S alignment suggesting culverts could continue, either under or in bridging pipework, through the coke loading bay between the two banks of ovens.
2296	Group	Tram Sleepers	See below		Group of nine stone blocks used as sleepers for a tram way. All have the remains of iron pipes to hold a rail. One part of the group is a line of 6 blocks forming the NE rail, the other forms the SW rail but then have been cut by the cut for brick chamber 2297, which has destroyed one block in the sequence. The blocks are set 1.01m - 1.03m apart (measuring pin to pin) and are 1.35m away from the next in line suggesting a gauge of 3'4". Each block is sandstone and some show signs of individual shaping to accommodate the rail. The blocks on average measure 360mm x 340mm with an unknown depth. Four blocks have staining from the ghost of an iron rail.
2297	Structure	Brick Built Chamber ? Water control feature	0.85m deep x 1.13m W x 1.37m L		Rectangular chamber built from yellow refractory bricks. Has raised sides along long axes (1 brick wide) and a small drain set into the SW face of the chamber at a depth of 0.38m from the top. There is iron staining at the NE/SW ends of the raised brickwork, suggesting iron capping at these ends. The drain appears to lead to stone culvert 2301 located some 1.07m south west of the chamber. Has a base of yellow brick. This feature may be a tank disguised to hold surface water, with the excess running into stone culvert 2301. The bricks that form the NE/SW lip of the chamber have rounded upper ends, possibly caused by the erosion from the ingress of water.
2298	Negative feature	Cut for brick chamber 2297	2.6m x 1.4m Depth unknown but exceeds 1m		Irregular cut into coal dust surface 2306 to allow the construction of brick chamber 2297. The cut can easily be seen to the NE and south of the chamber but less so on the other sides.
2299	Negative feature	Cut for stone culvert 2301	4m x 1m as exposed	>0.31m n.b.	Probable cut into coal surface 2306 for the construction of stone culvert 2301. Difficult to visualise but may be seen as a line of white/grey mortar to the external rear of the stone culvert 2301.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2300	Negative feature	Construction cut for north coke ovens	1.4 - 1.75m W	Unknown	Construction cut for the north range of coke ovens. This substantial feature is on average 1.5m wider than the wall of the oven, possibly to admit scaffolding.
2301	Structure	stone built culvert	4m long 1m wide	internal 310mm x 310mm	Bow culvert constructed from worked but not faced sandstone blocks no obvious bonding material but may be a grey white mortar that has washed out. Staining of upper stones and residual material indicates a capping or iron plates. 3440mm x 290mm x 90mm for average block size. Appears to have been blocked by brick towards south excavated extent and later brick culvert built to drain into it from the west, to the east a drain has been added to drain from brick chamber 2297 and a lintel 2304 added to support drain.
2302	Structure	brick culvert joining stone culvert 2302	250mm wide, 740mm long		Remnants of a brick built culvert that joins stone culvert 2301 and probably drains into it. The adjoining section consists of 6 yellow refractory bricks bonded with light grey mortar forming a shallow curve to the south west of stone culvert 2301. A more substantial and probably complete section of it survives in the excavation section. This suggests the culvert was of simple construction, some similar bricks survive on the east section of the stone culvert supporting the rebuild theory.
2303	Deposit	blocking in stone culvert	270mm deep 270mm wide 370mm long		Blocking formed by a combined deposit of brick and coal dust, deliberately laid in the channel of the stone culvert 2301. Bricks are yellow refractory type measuring 245mmx115mm75mm. The blocking is located immediately south of the apparent mouth of the brick culvert 2302 and probably is an attempt to block drainage from or backflow into 2301 south of this point.
2304	Structure	Fe lintel in stone culvert 2301	580mm x 160mm		Iron lintel built into stone culvert 2301 to create an opening for a small drain into the culvert from the north east (draining brick chamber 2297) Drain measured 200mm x 220mm at mouth interior 2301. The lintel is probably formed from 2 iron strips each 80mm wide. Appears to be a later addition to 2301 probably contemporary with 2297.
2305	Object	Fe capping on culvert 2301	0.6m x 0.19m at widest 30mm to 50mm thick		Heavily corroded iron plate acting as capping for stone culvert 2301 only partially exposed, the rest is buried in the section edge.
2306	Deposit	coal dust surface			Fine, compacted coal dust forming a distinct surface on which tram sleepers 2296 are placed and into which stone culvert 2301 is set. The compaction is particularly pronounced between the sleepers of 2296 where a shallow U shaped channel has been formed, presumably by what or whoever is pulling the tram trucks.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2307	Deposit	remnant of Fe tram rail	110mm wide 3.46m long		Ghost of tram rail visible as compact iron staining left on coal surface 2306 and sleepers 2296. It is not clear whether this is the remains of one or more rails as the staining does not differentiate
2308	Deposit	fill of stone culvert 2301	270mm depth 4m long as excavated		Deposit consisting of coal dust some of which has a silty texture reminiscient of putty or clay. Contained by drain 2301. The base of the deposit is similar but is much more compact forming a discrete surface. This base corresponds with the base of the stone culvert
2309	Structure	brick manhole chamber	1.46m wide 3.46m long	1.33m base not excavated	Late 19th early 20th century brick manhole access chamber for Phase 2 culvert or repair of culvert post construction of Coppée ovens. Cut for this feature is through made up ground for coke bench. Culvert runs n-s with double brick courses arches in N and S walls.
2310	Negative feature	cut for feature 2379	200mm deep full depth unknown		Linear N-S construction cut for stone lime mortared feature wall 2379 Approximately 4.5 length exposed. North end truncated by later 2300 parallel to and approximately 450mm east of rear edge of wall 2379 west side appears shallower with possible working access slope.
2311	Negative feature	intrusive cut through 2219	length-0.9m w-0.36m		This cut has had some bricks removed showing the fill 2312 and an iron object underneath it. It is uncertain how this cut was made. Possibly by some form of machine during the demolishment of the works see 2219
2312	Deposit	fill of cut 2311			This dark grey black fil is sitting under the brick floor 2219 with an iron object sticking out of it. This fill seems to be similar to 2407 and may be to the fill with the cut 2228 running either side
2313	Deposit	coal dust and clay fill	4.95m length w=0.83m	1.35m	Fill between 2215 and 2315 composed of coal dust and small pieces of coal along with clay and earth. A section was made to see what the layers of strata were and we found that clay is in the middle of the silt and it seems likely that all these deposits were tipped in from the top of 2215 due to the angle of the layers. Some of the bricks an top leaning against 2216.
2314	Structure	brick structure	L-41m W-1.45m	1.1m	Linear wall probably used to support a roof, original height is lost due to damage which also has created a step like look which however would have been flat when constructed. On E side only one course of bricks remains and extends beneath spoil. Bonded with 2315. On N side there is a step 17cm from base and is 10cm protruding

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2315	Structure	Brick structure wall	L=7.65 W=0.36m	1.28m	Brick structure wall, 2 courses wide at northern side 3 courses wide at southern in one area. Northern most edge is untraceable bar soil change. Colour variation some damage evident surviving wall length is 3.43m min height one course of mortar at northern edge. Suggestion that 2313 and 2319 are the same fill of this is so the wall being described may have continued and adjoined brickwork 2320. Raised section ay the bottom, illustrating relationship with 2314 constructed around the same time. Adjoining wall height to shelf 1.17m
2316	Deposit	Fill of trench cut 2300	41m L x 1.6m W		A fill of trench cut 2300. The fill of consists of a range of materials from sandy grit. Pebbles and also medium to large sized stones. At the south side of the fill there is a cut for a mortar plinth for a manhole. Everything else on the south side is cut by it. The relationship with 2314 is unclear, however the wall is later.
2317	Structure	Brick Wall	0.7-1.26m L x 0.49m W x 1m H		Brick structure adjoining 2315 possibly the same structure as 2328 although more is remaining at the western edge possibly due to adjoining wall 2315 position on the same alignment as 2328and has the same mortar used light grey mortar. Considerable damage to eastern edge.
2318	Structure	Brick Wall	Base: W 0.7x0.54m H1.29m Top: 0.45m W		Brocken brick wall. Base still remains. Some brick on top still remain to adjoining wall. Bricks in middle of wall have been removed creating a gap in the adjoining wall. Mortar remains on base and in gap in adjoining wall.
2319	Deposit	Coal and clay fill	0.87m W x 1.04m H		Black sandy clay fill mainly constructed from coal dust and clay. Contained by 2320 and 2220. Evidence of rubble fill of a later date at the top of section soil change in colour suggests continuation into 2313. Suggesting that they are the same fill contained by 2315. Clear definition between soils, variation of soil colour in a linear spread at the current floor level showing differential between fills 2313, 2319 and floor level to the east. Floor is at a level where we have dug it to not true floor level/limit of excavation.
2320	Structure	Brick structure	2.85m L x 1.18m W x 0.75mH		Brick structure composed of red brick. The base is stepped where bricks seemed to have been removed. Mortar is showing. Poor condition. Top is more level with bricks removed towards right end. Stepped base using headed brick bonding. Top wall using English bonding.
2321	Negative feature	Recess with timbers	3.15m L x 0.9m W Timbers 1.46m L x 0.32m W		Cut in wall 2324. Contains two pieces of timber exactly the same size in length (1.46m) and width (0.32m). Timber on left is broken in two pieces in poorer condition than timber on right. Stretcher bricks on first course and header bricks on second course.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2322	Group	Brick Channels and Flue	3.6m L x 6.5m W		Group composed of 4 parallel walls 2331, 2330, 2339, 2328 divided by dress 2332, 2333, 2334, 2335. Also composed by flue 2340 and chimney 2338. Use of the brick channels is unknown, but two walls appear to divide some of the channels, the walls being 2336 and 2337. The group is truncated on the west and may have continued to wall 23125. E side obscured by soil.
2323	Structure	Wall	5.94m L x 1.71m H (S end) 1.3m H (N end) x 1.14m W		N-S aligned wall overlying coke oven floor 2369 and foundation cut 2376. at 0.79m from base of wall. Above this level the wall narrows to a width of 0.97m. Random coursing.
2324	Structure	Linear Wall	34.6m L x 1m W x 1.83m H		Wall of group 2360 paired with second wall 2392 which appears to be an add on with similar material component. The foundation cut is 2376. The height of the top from the base of the wall is 1.23m. Not clear if 2324 or 2392 predates the other. Cut by flue 2391. Step extends 15cm out upper part of wall. Stone blocks are roughly coursed plinth of 2323 is on top of plinth of 2324 therefore suggesting and later build.
2325	Structure	wall above fill 2398 part of extension of walls	6.75m length 0.15m width	0.9m	Wall structure above fill 2398 used to strengthen butting walls 2395 and 2396. Butts walls 2324 and 2326 suggesting it belongs to a later phase. The base seems to be constructed on the floor level present at the time. Has a single plinth at the same height as the one in 2324 plinth is 35cm from base and protrudes 17cm
2326	Structure	linear wall	L=34.4m W=1m	2.2m	Linear wall parallel to 2324. 2 plinths present one at 0.76m from the base and one at 1.42m from the base. The lower plinth projects 20cm from the wall and the second 22cm. Both are located on the southern face of the wall with no evidence on the northern side. Wall consists of roughly shaped sandstone and limestone blocks with lime mortar. The lower plinth is located underneath the plinth of 2323, hence makeup the wall 2326 earlier than 2323.
2327	Group	group of walls	L=34.6m w=9m	1.83m	Rectangular bay composed of walls 2324 2323 2326 and the complex 2325 2395 2396. Wall 2324 was built first followed by 2396. 2325 and 2326 next added on as extensions with 2323 added soon after. Finally 2325 was built to strengthen 2395 and 2396 2388 was added on to 2324
2328	Structure	brick walling	L-32m w=0.7m	0.09m	Brick wall parallel and similar to 2331 2330 2329. A single course of brick remains but would have probably been higher before collapse. May have extended up to 2315 along with 2317 this would also be in line with a brick line 1.7m long and 0.23m wide found 2.15m from the east end of 2328

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2329	Structure	brick wall	33m-L 3-17cm deep width 0.72m		Linear feature part of group 2322. One course of bricks showing except between 10.6m-14.45m where two courses are showing. Shallow west part of Feature can be between 0-3cm whereas it can go to 17cm deep, mortar visible
2330	Structure	Brick walling	34.6m L x 0.7m W x 0.09m H		Brick wall parallel and similar to 2331, 2329, 2328. Only a single course of bricks remains, except between 12.40m and 15.1m from west where two courses remain. 6.3m from the east it is adjoined with 2377 and 6.05m in with 2336. May have extended up to wall 2315 but evidence is inconclusive (obscured by soil)
2331	Structure	Brick wall	33.2m L x 0.92m W		Linear feature 33.2m in length until it is obscured by debris on west end. Outside is using headed brick bonding. Mortar visible. Only one course of brick visible.
2332	Structure	Brick channel between 2314 and 2328	33m L x 0.84m W		Fill in-between wall 2314 and 2328. Orange/red in colour, sandy in texture. Small stones frequent although may be part of a different, later fill identical to 2333, 2334, 2335. Mortar rich.
2333	Structure	Brick channel between 2329 and 2328	33m L x 0.85m W		Fill/channel between 2329 and 2328. Red white in colour. Mortar rich fill small rubble frequent. Possible degraded mortar floor.
2334	Structure	Channel between 2330 and 2329	34.6m L x 0.84m W		Base between wall 2330 and 2329, made of degraded mortar. Identical to 2332, 2333 and 2335. Divided by wall 2336. Filled with bricks and white lime mortar.
2335	Negative feature	Channel between 2331 and 2330			Filled with rubble. Partially excavated to define 2330-1.
2336	Structure	Brick block wall divider	0.86m L x 0.23m W x 0.05m H		Small wall one brick thick used to divide walls 2330 and 2329. Only partially remaining original height unknown. Mortar on top suggests higher than what is currently present. Found within 2334. Its placed 0.23m more E than similar structure 2337. Bricks placed in a single row, joined by their long sides.
2337	Structure	Brick blocking/divider	0.86m L x 0.23m W x 0.05m H		Small wall, one brick thick, used to divide walls 2330 2331. Only partially remaining, original height unknown. Mortar on top suggests higher than what is currently present. Found within 2335. It is placed 0.23m more West than similar structure 2336.Bricks placed in a single row joined by their long side.
2338	Structure	Chimney	2.03mL x 1.83m W x 0.3m H		Chimney part of flue 2340 and of flue 2391, with rectangular base. Walls E and W facing also rounded. On N side there is a flue supported by pillar 2339. Clear signs of vitrification and of fire damage throughout. The structure would have been covered by an arch now gone.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2339	Structure	Brick Pillar (Vitrified)	1.2m H, 0.5m L, 0.36m W		Pillar used to support flue 2391 and probably built together. Strong signs of vitrification and heat damage. Supports archway with signs of collapse and similar vitrification. Placed 0.76m from either side of flue.
2340	Structure	Flue floor (vitrified)	8.64m L x 2.06m W		Vitrified floor of the flue composed of numerous brick layers, yellow bricks although higher courses are vitrified lower courses do not seem to be heat affected. Vitrified area concealed in brown burnt material. Flue pillars of visible at the western end of the vitrified floor. Chimney 2338 is visible at the eastern end of flue and vitrified flue floor.
2341	Structure	Rectangular manhole/drain	2.55m L x 1.45m W		Rectangular manhole over drain extending N-S. Partially excavated. Drain proceeds possibly under walls 2324 and 2326 and the manhole appears to be cut into the layer 2372, although relationships are hard to define. Bricks laid in English garden lawn pattern and are frogged.
2342	Negative feature	Trench for manhole	5.19mL x 2.3m W	Unknown	Cut of possible drain/canal within which we have manhole 2347. Cut into floors 2372 and 2387. Contains fill rich in charcoal and bricks. Underlies walls 2324 and 2326. Possibly associated with 2328.
2343	Deposit	Fill of trench cut 2294	14m L x 0.43m W		This clay fill marks the foundation cut for the wall 2133 and 2136. It is visible as a light colour against the dark coal dust of 2344.
2344	Deposit	Coal dust deposit			This coal deposit surrounds the whole area around the culvert and canal walls along with stone wall 2133 and the manholes and rests against the foundation cut 2294. It may have been deposited here as a waste site during production.
2345	Deposit	Course gritty coal overburden	0.5m Deep as excavated		Gritty coal 'waste', overburden. Make up material to raise ground level for Coppée oven quenching bench as part of northern oven system.
2346	Deposit	Make-up overburden deposit		200mm approximately	Compacted coal dust/grit. Has a thin intermittent rusty iron brown lens on upper interior surface with 2345. Possible temporary working surface. Overlies culvert 2295 and 2306.
2347	Deposit	Orange 'Brick clay'.	2.5m W, <0.28m deep		Well defined orange brick clay deposit overlying and sealing culvert 2295. Main stone element including side walls. Sits within upper portion of construction cut 2354. Either prevents water washing lime mortar out of the arch or acts as a warning to 'future' excavators/builders.
2348	Deposit	Back fill over stone arch of 2295	2.2m W x 200mm deep as excavated		Grey/black shale/clay/coal waste initial backfill over culvert 2295. Underlies orange brick clay sealing deposit 2347.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2349	Deposit	Lime mortar layer, overlies east wall 2355	30-40mm		Layer of light grey coal rich lime mortar overlying wall 2355 and arch 2357 (and east side of).
2350	Deposit	Upper silting deposit within culvert 2295	90mm deep		Dirty grey silty clay upper silting deposit within culvert 2295.
2351	Deposit	Main silting deposit within culvert 2295		360mm	Silty and fine gritty coal waste silting deposit within culvert 2295. Forms the main silt deposit for the culvert during its active life. This deposit effectively protects the inner elevations of walls 2355; 2356, where exposed courses have clearly suffered erosion.
2352	Deposit	Thin 'primary' fill of culvert 2295. Construction		20mm	Primary base fill of culvert 2295. Comprises iron stone fragments, grit and fine silt, construction waste.
2353	Structure	Stone base of culvert 2295	Width 1.06m		Edge laid, stretcher bonded iron/sandstone. No evidence of mortar. Well-constructed with tight fitting 'courses'. Gaps between stones filled with gritty 'iron stone' waste (same as 2352). Abuts side walls 2355; 2356. A quality piece of stone workmanship.
2354	Negative feature	Construction cut for 2295			Construction cut for 2295
2355	Structure	East wall of culvert 2295	0.59m high		Stone side wall of culvert 2295. Flat faced stone work in good condition to level of silt fills. Upper course/courses eroded and worn above final level of 2350. Level stretcher courses using 120/100mm thick stone; 250-450mm with occasional smaller spacer stones 40- 80mm. Appears to be dry stone construction, only fine silty dark grey 'clay' being noted within joints. Presumably to allow in to main culvert run initially. However, clay silting would soon prevent this. Alternatively, the wall many have been 'bonded' using clay to make water tight, more likely I suspect.
2356	Structure	West wall of culvert 2295			Stone side wall of culvert 2295. As with 2355, the upper un-silted stonework shows signs of erosion rounding off sharp edges of previously flat/ squared stonework. Construction same as 2355 with level stretcher coursing. Stones again 250-450mm long 100 to 120mm deep. Joints range between 5 and 15mm. No mortar just dark grey clay. Drystone construction technique 'bonded' or 'sealed' with clay.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2357	Structure	Arch element of stone culvert 2295	Approximately 300mm thick;1.12m internal width		Low shallow stone and lime mortared arch. Forms cover element of culvert 2295. 210mm high from spring point to centre of arch. Appears to be the only lime mortared element of the culvert. Flat and wedge shaped stone, bonded with coal rich lime mortar. Stone rough dressed internal faces. Makes use of occasional large 'keystones'
2358	Negative feature	Trench for wall 2213 (construction cut)			Construction trench cut on west side of wall 2213. Cuts yellow sandy clay possibly natural or redeposited natural from initial site ground works in the 18thC. Also cuts shale waste type material. Cuts earlier structures 2249 and 2250.
2359	Deposit	Fill of trench cut 2358			Silty loam and coal waste backfill of construction cut 2358 for wall 2213
2360	Group	Early coke oven floors/walls			Early coke ovens. Floors and walls demonstrating a different alignment to later works such as masonry walls 2363 which overlies 2360. Coke oven floors are constructed from red bricks although in many areas they are stained and concealed under possible coke by products. Two earlier walls are visible, constructed from red bricks 3 courses in width. These are the back/front of the coke ovens. The dimensions are smaller than the later coke ovens. There is a recess that runs the length of the floors of the oven and has been interpreted as a doorway. Within the floor itself where the walls end there appears to be a metal object that has been interpreted as a mechanism for the door. They are parts of the machinery used to lift the door.
2361	Negative feature	Pit for support for door mechanism. Possibly	Length 1.10m by 1m in width		Unexcavated pit almost identical to 2362, contains one single fill 2373
2362	Negative feature	Pit	1.00m x 0.72m	Excavated to a depth of 0.80m	Possible coke oven door mounting pit. Near vertical sides, and cut along SE face of wall 2365. Full depth of pit unclear as partially excavated to a depth of 0.80m.
2363	Negative feature	Cut of drain containing manhole 2341	Length 5.60m; width 1.60m		Linear drain containing manhole 2341. Goes underneath walls 2324 and 2326 although relationships are hard to define. Appears to cut into floor layer 2372. Equivalent to 2378.
2364	Structure	Brick wall			Stretcher bonded brick wall, three courses wide aligned north east south west. Three courses are visible in height. Bonded with light lime rich mortar.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2365	Structure	Wall	1.67m long x 0.74m wide	0.80m visible depth.	Coke oven dividing wall, three course red brick construction laid in stretch bond NE-SW which survives to a visible depth of ten courses. S 'horseshoe shaped' iron mounting affixed to the SE face of wall at a depth of 0.67m. Mortar bonding of wall appears to have been heat affected. No manufacturers name on bricks. Brick dimensions 240mm x 120mm x 75mm (unfrogged).
2366		Cover oven door slot	1.53m long x 0.12m wide	0.04m	Red brick channel. Bricks laid on bed in a stretcher bond. Brick dimensions 230mm x 120mm x 100mm no manufacturers marks or frogs visible. Bonded agent of light grey lime mortar. Channel possible represents a slot for a sliding coke oven door. Given the dimensions of associated pits for mechanism 2361; 2362 it is possible that a pair of sliding doors were used to access the front of the coke oven to enable coke removal.
2367	Deposit	Spread of hardened coke			Deposit of hardened coke residue. Sits upon floor 2372. Concretion may suggest a long period heavy usage or potentially the remainder of the last firing.
2368	Structure	Wall	0.68m x 0.47m		Dividing wall of earlier coke oven constructed of yellow refractory bricks (no makers name), laid in stretcher bond (NE-SW) of which only a single course survives.
2369	Structure	Brick floor	Surviving width = 1.78m by 2.81m		Brick floor of early ovens group 2360. Underlies later wall 2323. The bricks have been bonded stretcher pattern. Bonded by coal rich mortar. Brick size measures 0.225m in length by 0.08m in width by 0.11m deep. No makers mark present. Consists of two courses at least.
2370	Structure	Oven floor	Length 2.81m by width 1.74m		Stretcher bond red brick floor aligned in a northwest - south east alignment. Bonded with white lime rich mortar. Underlies wall 2326.
2371	Structure	Brick floor	Length 1.12m width 1.40m		Oven floor. Continues under wall 2326. Made of bricks in stretcher pattern bonded with lime mortar. Interior of coke oven. Cut by 2389.
2372	Structure	Bench floor	Length 5.35m by 3.50m in width		This floor is formed from stretcher bonded laid on edge bricks. Appears to be a combination of red and yellow bricks. Partially obscured by coke residue therefore suggesting the floor was used whilst quenching coke down from adjacent ovens. Truncated on its south western and north eastern sides. Brick size measures 0.23m in length by 0.15m in width and 0.07m in depth. No frog or makers marks present.
2373	Deposit	Fill of 2361 (unexcavated)	Length 1.10m width 1.00m		Dirty white mortar contains several brick fragments. Appears to be back fill.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2374	Deposit	Fill of pit 2362	1.00m x 0.72m	0.80m (partially excavated)	Singular fill of pit 2362 consisting of a friable mid red lime mortar with occasional flecks of coal waste.
2375	Deposit	Layer			Compacted mixed deposit of mortar and coal waste. Deposit probably represents the sub-base of the formation layer for coke bench floor 2372.
2376	Negative feature	Foundation cut for wall 2324	Length 31.10m width 0.50m		Foundation cut for wall 2324 located on the structures northern side. Appears to go under wall 2323.
2377	Group	Pillar bases in floor 2012	Group length 30.10m.		Pillar bases upon flue floor 2012. Square in shape (0.38 x 0.38m average dimensions). Brick pillar bases showing some evidence of heat affected bricks. Used to support pillars. Variation in spacing, majority at 1.80m with some at 2.40m. There appears to be spacing pattern following two pillars at 1.80m apart then followed by two 2.40m pillar bases. The recording of this was limited because of asbestos. The bricks appear to be yellow in origin however are stained from heat affected.
2378	Structure	Brick capping south of brick chamber 2309	2.43m by 1.80m in plan	450mm exposed. Full depth unknown	Brick capping over brick culvert accessed by manhole/ chamber 2309. Mix of yellow and red half and full reused bricks. Some having vitrification or heat damage evidence. Lime mortared, with a dump of unused lime mortar close to southern limit (see drawing 22) Construction cut and backfill suggests construction through the coking bench and thus post-dates initial construction of the coke ovens.
2379	Structure	Stone and lime mortared linear feature	Approximately 0.80m wide	240mm exposed. True depth unknown	Damaged stone and lime mortar feature. Pre dates insertion of culvert 2378/2309. Construction cut 2310 on east side (see drawing 32). Eastern edge clear, western edge damaged by later feature 2378. Stones on western edge slumping or tipping interior area of 2378, either represents construction damage, or possibly the start of an arch. Not able to excavate further to clarify. However, as the line appears the same I would suggest an earlier stone culvert has required repair/ replacement post construction of the coke ovens.
2380	Negative feature	Cut for drain	Width 0.65m	0.63m	Primary cut for brick lined drain 2383. Appears to continue under walls 2324 and 2326. Has a later recut 2386 present also with its fills. The north western side was not fully exposed as this lay under mortar floor 2387. Sketch on back.
2381	Deposit	Fill of drain		0.63m	Mottled black silty clay with red clay spots. Primary backfill of drain cut 2380. Been truncated by later cut 2386.
2382	Deposit	Fill of 2386		0.50m	Fill of (illegible) cut in drain 2383. This fill mostly contains the shattered remains of fire bricks and appears to have been used as drainage fill for brick drain 2383.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2383	Structure	Brick drain			Linear brick drain partially destroyed. Consists of two single lines of bricks spaced 0.20m apart to form a channel. The structure is contained within cut 2380
2384	Structure	Stone sleepers - Tramway			Tramway sleeper blocks (x5) set into a formation of crushed coal. Blocks were positioned to accommodate 3ft (0.90m) tram plates of possible L shaped edge rail form. The gauge of the tramway was 3ft 7in (1.18m) and narrower than standard gauge used on railway lines which is 4ft 8.25ins (1.413m). Between the surviving sleeper blocks the formation was very heavily compacted and is considered to indicate that the tramway was possibly horse or human powered. A series of tramways serving a 'coke yard' and coke ovens are shown on the First Edition OS map but appear to have been abandoned by the publication of the Second Edition OS map when the area had been redeveloped with the construction of new larger coke ovens.
2385	Negative feature	Recess in wall 2052 - timber slot	0.19m long x 0.16m wide	0.11m	'U shaped' cut recess in east wall of 2052. Aligns with timber sleeper 2115.
2386	Negative feature	Re-cut in drain 2383	Width 0.55m	0.51m	This cut appears to be a re-cut in brick drain 2383. The re-cut may have been undertaken to improve drainage as the drain was then backfilled with deposit 2382 which consisted solely of fire bricks. This then would have allowed more water to enter the drain. This second cut seems to have truncated floor 2387 which may suggest that the drain had been previously covered by the floor.
2387	Deposit	Mortar floors NE of Welsh Ovens	Length 40m x 8.20m wide		Very compact mortar surface NE of Welsh Ovens. Cut by drain 2342 and overlying surface 2381. Probable living (working?) surface. May exterior end underneath 2326 and 2374 but evidence is unclear. Cut by foundation trench 2376.
2388	Structure	Brick wall	Length 2.30m; width 1.93m; height 1.00m		Later addition to wall 2324, butting 2323. On southern side 1.00m from the join with wall 2324/2392 the wall comes in 1.00m to create platform with wooden base. Base of wall starts at wall 2376s plinth. Within we have a square box NF (????) with 0.25m sides. Bricks in English garden wall pattern.
2389	Negative feature	Gully within brick floor	Length 2.10m; width 0.50m		Cut of gully within brick floor 2371. Containing fill 2390. Possibly a later drain.
2390	Deposit	Fill of gully 2389	Length 2.10m; width 0.50m		Fill of gully 2389. Contains a number of large stones.
2391	Structure	Brick Archway			Destroyed brick tunnel covered by part of curved brickwork on each side. No indication of being fired. Possibly relieving arch or cold air for the lower flue

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2392	Structure	Linear wall	34.60m x 1.05m wide x 1.85m high		Linear wall forming pair with [2324]. Not clear which is earlier than the other. Cut by flue [2391]. Stone blocks are roughly coursed. Bound together by lime mortar. No plinth evidence unlike [2324]
2393	Deposit	Rubble fill to west of 2338	9.30m x 0.73m wide	1.10m high	Fill between flue [2342] and wall [2392] composed of a sandy deposit with large and peculiarly shaped bricks. Base is composed by a flat surface with three brick steps next to [2340] and multiple brick steps next to flue [2391]. Possible rubbish dump/ levelling layer.
2394	Deposit	Rubble fill to east of 2338	9.00m x 0.82m	1.36m (approximately)	The width between [2435] and [2437] is 0.82m. Rubble fill between wall [2437] and flue wall [2435]. Rubble was in 2339 but was removed and here it goes to a depth of 1.36m. The rubble includes red brick whole and broken, stone, yellow brick/ stone lime mortar, darker grey mortar, slag, light grey mortar with bits in.
2395	Structure	Wall contemporary and part of wall [2326]. Part of	2.60m x 0.80m	1.80m high	Extension of wall [2396], built with wall [2326]. Creates support for flue [2391]. Later on strengthened by [2325]. Built using bricks that then mix with stone in the northern corner to facilitate joining with [2326], however bricks still form the entirety of the eastern face.
2396	Structure	Wall extension of [2324]	4.15m x 0.90m	0.30m (????) high	Wall running off wall [2324] and later on extended with [2395]. Part of flue [2391] and foundation for the flue. Later on strengthened with wall [2325]. Built on plinth of [2326] so of later date, Probably contemporary with the destruction of part of wall [2324]
2397	Negative feature	Cut of foundation deposit of wall [2325]	6.60m long		Cut of deposit [2398] which forms the base of wall [2325]. Unexcavated. Seems to be later than [2324]; [2326]; [2395] and [2396]
2398	Deposit	Deposit within cut [2397]	5.80m long		Fill of cut [2397] made of bricks and sandy grit. Possible levelling layer or dump within base foundation for wall [2325], although not clear if it is dumped for this specific purpose.
2399	Deposit	Coal surface	6.74m		Coal deposit forming floor layer on which sleepers (2384) are rested. Cut by [2380] and wall foundation [2376]
2400	Negative feature	Construction cut for brick culvert 2309/2378	3.75m wide	660mm deep	Steep sided cut through coking bench down to earlier Feature [2379], for insertion of replacement/ repair section 2378.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2401	Deposit	Main upper backfill within 2400	3.8m wide	1.00m deep as excavated	Main upper backfill over replacement culvert [2378]. Clear tip lines showing on each side. More mixed on west side overlie slump deposits. Yellow sandy clay with thin coal waste lenses forming clear tip lines.
2402	Deposit	Initial backfill/slumping into cut (2400)	3-7m wide	up to 700mm deep as excavated	Appears to be initial backfill or slumping within 240. Grey, clay coal waste.
2403	Deposit	Demolition waste over wall [2379]			Rubble, lime waste in coal dust matrix. Demolition waste over wall element [2379]
2404	Deposit	Upper surviving fill of 2310			Yellow clay deposit within cut [2310], cut by [2400]. Evidence on west side suggests this may be a 'sealing' deposit over Feature 2379, in similar fashion to the orange sealing deposit noted within culvert group 2395 to the east of this feature.
2405	Deposit	Lower fill of 2400		400mm excavated but not bottomed	Appears to be lower fill of cut [2310]. Consists of coal dust and fragments.
2406	Negative feature	Intrusive cut in floor 2219	1.17m x 1.44m		Intrusive cut in brick floor 2219. Unsure of what or how it was made. Estimate between 55-60 bricks have been removed. Some mortar still left around edges of remaining bricks.
2407	Deposit	Fill of cut [2406]			Fill in cut [2406]. Top layer contains crumbled mortar. Dark grey in colour. Maybe same fill as 2312 but unable to tell. Fill seems to be soft as brick floor 2319 has sunk in the middle
2408	Structure	Coke oven floor	1.66m x 0.74m		Early coke oven flor constructed from bricks, appears to be coke oven corner as it abuts the back wall of the coke oven and separated from 2410 by brick dividing wall [2409] From wall [2426] it is apparent that the floor itself was at once stage replaced although it is not apparent from the floor layer itself but can be seen upon the north western walls face where grey mortar can be seen to hold up the repair of the floor. The floor is on the same alignment as the others to the south of wall [2326]. Bricks are once again red however have become stained through use.
2409	Structure	Coke oven dividing wall	1.68m x 0.86m		Dividing wall through coke oven flooring 2408 and 2410. Constructed from brick yellow in colour. Floor and facing of south west wall has been replaced. The bricks are stained red through heat.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2410	Structure	Coke oven floor	2.28m x 1.76m		Early coke oven floor as it is on a different alignment to the later features such as 2326 etc. The dimension of the earlier coke ovens are smaller than the later larger ones. These bricks are red but have been stained black from coke residues. All laid on edge. This is the same alignment as 2370.
2411		Coke oven dividing wall			Red brick wall, divider of coke oven floors. 3 courses wide all in alignment of stretchers. Possible continuation of walls on south of this.
2412	Structure	Coke oven floor	1.54m x 1.17m		Partly excavated coke oven floor. Early coke oven due to alignment. Bricks are red brick although stained black from coke. No evidence of makers marks.
2413	Negative feature	Cut for pipe trench	1.30m x 0.40m		Cut through masonry wall [2918] and brick trough [2201] for the course of a modern pipe trench. No visible signs of the pipe or any bedding cement.
2414	Negative feature	Cut for pipe trench	1.36m x 0.40m		Cut for the course of a modern pipe trench running N-S. cuts masonry wall [2199] and brick trough [2202]. No remains of the actual pipe seen. Remains of modern concrete adhering to masonry wall [2199]
2415	Structure	Brick base	4.30m E-W; 2.8m N-S	At least 0.70m depth unknown	Damaged platform adjacent but earlier than 2055 which has been incorporated into 2055 and 2052 probably cutting it off. Dense hard grey mortar covering brickwork and stonework. Both yellow and red brick present. Yellow brick irregular size, probably once part of the flue, now reused here. Surface uneven, top sliced off. Only definition is a length of red bricks to the south that contain the masonry and brick. Very irregular patch of reused flue bricks on SE corner of red brick wall.
2417	Negative feature	Construction cut	0.66m x 0.25m		This is the construction cut for wall
2418	Deposit	Fill of construction cut [2417]		0.39m deep	Secondary fill of construction cut [2417]
2419	Deposit	Fill of construction cut [2417]	0.25m wide	0.33m deep (partially excavated)	Primary fill of construction cut [2417] consisting of a moderately compacted deposit containing frequent coal fragments. Full depth and extent unclear as only partially excavated.
2420	Deposit	Layer next to [2417]	3.10m x 0.15m		Mortar deposit of moderate compaction.
2421	Deposit	Layer next to [2417]			Mid red mortar rich deposit underlying 2420. Deposit is moderately compacted and contains occasional slag fragments.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2422	Deposit	Layer next to [2417]	0.85m wide	0.55m deep	Coal rich deposit of moderate compaction.
2423	Negative feature	Pit containing metal mounting	0.60m x 0.90m	Unknown	Vertical sided pit, sharp break of slope at top. Similar to 2362. May have been excavated to access the bob stay. Appears to be located at the end of wall [2411]. Possibly used for door mechanism
2424	Deposit	Fill of pit [2423]	0.90m x 0.60m	Unknown	Rubble fill containing clay, lime mortar with flecks of coal. Mainly brick rubble remains. Small and medium stone/pebbles. Coal dust. Large heat affected stone, pink in colour. Only partially excavated, not fully bottomed. There may be possible metal bob stay at bottom.
2425	Structure	Bench extension of 2372			Extension of bench 2372. This is formed from stretcher boned, laid on edge bricks, mostly obscured by coke process residues suggesting it was used during the coke quenching as they were drawn from adjacent ovens. Bricks approximately 0.23m in length and 0.15m wide, 0.07m depth. No makers marks.
2426	Structure	Brick wall		1.20m high	Large brick structure/ possible wall. NW wall of earlier coke ovens. Runs SW to NE. Header bond construction. Friable creamy bonding material 11-13 courses, base consisting of medium sized stone blocks placed in the base of construction pit. Contains two bob stays at NW end of walls [2409]; [2407]. Upper floors of coke ovens replaced by (????). This is visible in the wall by later grey mortar in coursing. Maybe back/front of Welsh coke oven.
2427	Structure	Oven dividing wall	0.59m (exposed) x 0.43m (exposed)	0.30m (exposed)	Coke oven dividing wall constructed of yellow brick laid in header bond with grey mortar bonding. Brick dimensions 240mm x 110mm x 80mm. No manufacturers mark and unfrogged.
2428	Deposit	Metalled surface	0.82m x 0.54m		Heavily compacted possible floor surface revealed within sondage. Full extent of surface unknown.
2429	Structure	Brick infill	0.62m x 0.33m (partially excavated)		Red brick infill within NW corner of wall [2326]. Infilling survives to 8 courses laid in an alternating header/ stretcher bond and bonded with a coal rich lime mortar. Brick dimensions 230mm x 120mm x 0.75mm. No manufacturers marks or frogs visible,.
2430	Negative feature	Coke oven door mechanism pit	0.80m x 0.60m	Unexcavated	Pit for door mechanism of coke oven (unexcavated)
2431	Deposit	Fill of coke oven door mechanism pit [2430]	0.80m x 0.60m	Unexcavated	Fill of coke oven door mechanism pit consisting of a dark grey brown sandy clay containing frequent mortar fragments; moderate refractory brick fragments and occasional sub-angular stone. Unexcavated

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2432	Structure	Flue below flue 2391	7m long; 1.8m wide		Flue formed of firebrick underlying secondary archway with no sign of firing (relieving arch). Dense vitrification covering all surfaces within flue. Base dipping to north. Mortar clean pinkish brown to yellow brown- hard but friable. South end stops at a chimney and that end brick reinforced with regular sized brick which overlies larger brick. The lower brick yellow coloured, the upper reddish.
2433	Structure	Wall edge of flue 2391/2432	4.10m long; 1.25m wide	0.46m high	Wall made of stone and bricks bonded with a dark grey mortar. Along the inner wall there is a ledge 0.23m wide and 0.10m high off 2438. Towards the middle it is made into an arch shape to form an end of flue 2441. Iron plates 2444 are resting on this stone arch. This wall seems to be contemporary to the floors 2446; 2438 and 2439 although it seems likely that the floors were repaired. This wall seems to be later than 2437, possibly used to block off the flues 2391 and 2432 (See 2432 for further information)
2434	Structure	Flue floor	8.67m long; 2.05m wide		Made from yellow stone bonded with a light yellow mortar, possibly lime mortar. Some signs of heat flowing through this flue due to solid residue and vitrification on the top of the bricks. The rubble lining the floor is light and gritty. The edge of the floor where it meets flue 2391 lined with large yellow stones and drops to a depth of 0.83m and meets flue 2391 floor curve.
2435	Structure	Flue north outer wall	9.40m long; 0.30m wide	0.62m-0.81m high to flue floor	Yellow stone wall. Stones are different sizes. The top four courses show the curve of the flue. May have been bonded with lime mortar but now it has turned yellow. Is identical to wall 2436 as this forms the outer wall of the flue. There is evidence of heat passing through this flue on the inner side of the walls. Some chemicals or elements of the coke production have hardened and vitrified and burnt on the walls. The walls almost look like they have hard black moss growing on them. Some brown mortar remains on the top remaining stones. Most of the stones (BRICKS??) have visible makers mark/ stamps/ names stamped on them. The outside is covered by rubble fill 2394 next to wall 2437. An uncovered area reveals the surface is tidy with just some mortar covering the bricks and coming out of the cracks.
2436	Structure	Flue South of outer wall	9.40m long (to 2338) 0.23m-0.30m variable width	Height to flue door 0.19m (min) 0.74m (max)	The majority of this outer wall has been lost. On the west end only 2.15m of the wall is past the chimney 2338 still stands to a height of 0.74m. The wall is then lost in the middle apart from a small crumbly pile 1.05m wide and 0.25m high. It grows again towards the eastern end for 2.24m and 0.23m high. It is likely to have looked like 2435. The inside of the walls are burnt the same as 2435. These remains may be all that is left after the coke has been worked, the end solidifies onto the walls. The

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					outside has mortar stuck to the stone. There are bricks attached almost in a 'stepped' fashion in areas to the west, so another building may have been attached to this. These bricks come to 0.80m off the ground.
2437	Structure	Masonry wall	11.30m long; 1.92m wide	0.76m (min) 1.76m (max) height	Stone masonry wall bonded with lime and dark grey mortar. The grey mortar may be where later repair work went on, likely at the same time as the repair work on 2438 and 2439. The height of this wall inside is 0.84m. The depth of the outside where it drops in the rubble 2394 is 1.76m west. To the eastern end of the rubble 2394 the outside of the wall measures to 1.30m
2438	Structure	Brick floor	2.40m long; 1.98m wide		Mostly brick floor with the odd stone placed in grey mortar. Possibly repaired so it may be contemporary with 2433 and 2439. Later than 2442 due to mortar covering edged flue stones. There is a cut in the floor 2488 used to place bricks and stones to butt up against the flue 2441 to stop the large iron plates from sliding down which cover the manhole on the western end of the flue.
2439	Structure	Brick Floor	5.60m long; 1.34m (min) - 2.00m (max) wide		Brick floor with some use of stones. Dark grey mortar. Likely to have been repaired at a later stage due to some of the mortar covering the stones of the flue 2442. Bricks are a mixture of red and yellow. Some of the floor has come away. Either from the destruction of the flues or when the machines were revealing the area. The brick stone layout has no particular pattern. This floor seems to be contemporary with 2438. Towards the eastern end, which butts up against 2447 the bricks change to be bonded with a lime mortar - 2450. This may have been where the floor used to look like before it was repaired with the dark grey mortar. This light lime mortar area starts 5.50m along the darker mortar towards the east. It is 2.05m long and 1.20m wide. There is a definite edge where this area starts as the bricks are raised slightly in a line. This area seems to be in line with the stone to brick change happening at 2450 where stone was used to fill the gap when builders created the arch 2447 but the reason for the definite line and mortar change is uncertain.
2440	Structure	Brick Floor	6.70m long; 1.62m (min) - 2.00m (max) wide		Brick and stone floor bonded together with lime mortar which places it in the earliest stage of the construction. Patches have been stained yellow, possibly due to the heat passing through the flues. Some are red brick and stone. Vitrified rubble is overlying the eastern part of the floor 2454. Likely to be similar to 2455.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2441	Structure	Brick arched flue (cool air)	4.90m long; 2.36m wide	2.50m (approximately)	West end of cool air flue within Area 5. Constructed from yellow bricks measuring 22.5cm x 10cm x 7.5cm, on the outer edge and yellow slabs measuring 46cm x 30.5cm x 9cm within the inner edge and bonded with soft grey mortar. The east end, connected with chimney 2132, has been destroyed approximately half way. The west end is covered by iron plates 2444. Brick floors 2446; 2438 and 2439 are approximately located two thirds up the north and south sides of the flue. Additionally brick side flue 2442 runs off the south side of 2441. The north east corner is bonded with chimney retaining wall 2445 and the west end is cut and blocked off by wall 2433
2442	Structure	Brick Side Flue	2.04m long; 1.13m/ 0.80m wide		Side flue running off the south side of cool air flue 2441. Constructed from yellow bricks measuring 23cm x 7.5cm x 10.5cm on the outer edge and larger yellow slabs measuring 30cm x 11cm x 27cmfor the inner part of the circle. Only the top with a maximum width of 1.13m has been revealed. The west side is overlain by 2438 and the east side underlies 2439. the south end has been cut by wall 2437 and is blocked by it. There is damage to the majority of the top of the outer layer, resulting in most of the bricks being removed.
2443	Structure	Northern exterior masonry wall			Random coursed core of exterior wall bonded with a grey coal/coke rich mortar. Wall was originally faced with rectangular dressed stone blocks but apart from two courses at the base of the wall this facing has been removed. The possibly occurred during decommissioning of the site in the early part of the 20th century.
2444	Object	FE plates and brickwork over 2441	2.54m long; 1.21m wide		Collection of four iron plates measuring 1.21m x 0.61m x 0.02m each, over the west end of cool air flue 2441. One of the plates has been broken in half. There are three slabs on the south edge and two on the north edge of the collection. The iron plates are partially corroded and also overlie 2433
2446	Structure	Brick Floor	20.58m (max0 long; 1.84m wide		Brick floor placed between flue 2441 and 2448, wall 2445 and wall 2443. Constructed with a variety of bricks bonded mostly with dark grey mortar, with the area running along the north edge of 2448 containing lime mortar. Depth is unknown as floor was not fully excavated to base.
2447	Structure	Brick Arched Flue	1.85m long; 0.58m wide (see also comments box)	0.62m high	Brick arched flue constructed with yellow bricks measuring 23cm x 10.5cm x 8cm and bonded with yellow mortar. The inner lining is constructed using large brick slabs that are wider at one end allowing for the arch shape. The flue is partially revealed and continues into wall 2450. It is bonded with 2470. Has same construction as 2453.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2448	Structure	Brick Flue	1.55m of interior; 2.30m interior.		A hot air flue constructed in refractory bricks. A number of different shaped bricks used including wedge section bricks to attain a circular section. Brick built stabilising wedges support the flue and are considered here as part of the same flue structure. Onto these supports are built the outer circle constructed using half bricks. Inside this are laid the large wedge shaped bricks to form a tight circle. The interior void has a diameter of 1.55m. On the west end the flue has been blocked up by 2473 which reaches approximately halfway up the flue circle. The bricks at the west end are not vitrified (although the back end of the blocking was vitrified) but the bricks were discoloured through heating to a depth of 2cm. At the east end of the flue the bricks were slightly vitrified and heated to 3-4cm into the brick. A number of side flues leave the main flue to the south. These are 2447/2470 and 2453. These are later additions of have been repaired as the brickwork joining the main flue are quite different. The mortar bonding of the bricks of 2448 is a clay based pale yellow brown.
2449	Structure	Brick arched flue/ doorway	1.75m outside; 1.24m inside	1.80m high	Possible doorway (?) Part of wall 2451/2489 red brick, two bricks wide bonded into 2451/2489. Arch all headers V walls headers/stretchers. Doorway onto floor 2479 and blocked by 2504 covered by 2492/ 2493. Blocked by 2504. Red brick construction bounded with a soft white mortar containing occasional brick fragments. May be entrance onto floor 2479 for back of flue 2490. Some bricks on east side continue beyond line of wall 2451/2489. May have continued out onto floor 2479, though as it is bonded with wall 2451/2487 and floor 2479 abuts 2451/2489 was probably all part of the same construction. May have provided access to the flue bay during construction and then access to north side of main flue for maintenance.
2450	Structure	Brick Wall/ Floor	1.26m long; 0.87m wide	0.68m high	Potential similar structure to 2451 and 2452 (?). The brick wall/ floor is located to the west of flue 2447. This potential wall/ floor structure would have cut wall 2437 and nibble (?) 2394. The bricks/ rocks which make up the wall/ floor are scarred red with a layer of light grey mortar on top of each brick. The area 2450 is damaged. This is perhaps due to machinery or due to collapse previously. Only the bottom two courses of bricks can be properly identified. The wall continues southward, where the top layer of brick/stone is not visible as it lies under a light layer of grey mortar and brick dust. The south end of the north facing face looks similar to backfill 2498 and contained within 2494.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2451	Structure	Masonry Wall	1.23m long; 0.90m wide	0.49m high	A potential cut in wall 2478 to allow for a brick wall next to flue 2449. the wall has different sized bricks with the west side of 2451 (north facing) having a large foundation stone. The dimensions of this foundation stone are 0.42m (long) by 0.13m (height). There are three courses of varying sizes of stone before the top two courses are of brick, forming a regular course of bricks. The bricks are originally yellow colour but are stained red, with a layer of light grey mortar bonding each of the courses of bricks. The southern end of 2451 is similar to the backfill 2503 and contained within 2499. The average brick size is 0.23m (long) by 0.08m (height).
2452	Structure	Brick remnant wall	1.26m long; 1.10m wide	0.68m high	A potential remnant of a brick wall which may have been an addition to wall 2439. The potential wall consists of seven courses of bricks. The colour of the bricks are stained red, with a light grey layer of mortar. The level of the bricks are not all at the seven course height. At the fourth course of bricks there is a layer beginning to arch towards flue 2448. This pattern of arching bricks is repeated on the sixth course of bricks.
2453	Structure	Brick Arched Flue	A (interior. 0.75m; exterior 1.35m) B (interior 0.88m; exterior 1.48m)		(D.Davies) Yellow brick flue with light grey mortar, although in some areas the mortar has been stained yellow/orange. Outer layers of construction made with small yellow bricks laid stretcher in bond in the arch shape. Inner courses constructed from larger/ longer stretcher bricks some which are red others are stained red. Dimensions of longer/larger bricks approximately 0.45m length, 0.10m wide and 0.15m in height whereas the smaller bricks used on the outer phases and northern arch face are approximately 0.20m in length, 0.12m wide and 0.80m height. Northern face is constructed from stretcher yellow bricks and demonstrates a vitrified mortar spread coming from within the flue itself. 2454. Although this spread technically underlies the flue it is apparent that the vitrified material accommodated in the shape of the flue itself and therefore demonstrates the stratigraphic relationship. (S. Baker 13/09/2013) Brick arched flue constructed with yellow bricks 0.30m long. These bricks are wider at the top and narrow at the bottom creating the arch. The bricks are different width, some are smaller to close the gap in the arch. The tunnel has been unblocked and carries on through wall 2478. The bricks on the corner of the flue have curved outer corners. The bricks are bonded with 0.05m of hard yellow mortar with occasional grains of sand. The inner side of the tube tunnel is covered with hard reddish purple vitrified concretion due to the heat passing through. The outside of the tube is covered with vitrified concrete from the heat and

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					chemicals- 2454. The construction consisted of a U shaped cut through wall 2489 which was then partially backfilled by structural brick preparation 2500 creating a square shaped linear channel into which the lower end of tube 2453 was constructed. The upper course of 2453 was constructed and then a reinforcing arch or collar 2451 was constructed over the tube to support the upstanding wall. The southern end of the tube was then covered by brick structure 2502 intended to seal in the heat. Gaps on the southern side of the wall were then filled with structural backfill 2503.
2454	Deposit	Mortar Repair	2.08m long; 1.48m (max) 0.80m (min) width		A large patch of vitrified mortar, with yellow and orange patches of brick dust on top of the mortar. The mortar looks as if could be a repair on the top of a flue which would join flue 2448. Rocks can be seen within the mortar which range from pebble size to medium sized stones.
2455	Structure	Brick Floor	1.30m long; 0.42m wide		Continuation of floor 2440. Yellow and orange patches of brick work floor. On the north side of 2455 is a patch of vitrified mortar repair (context number 2454)
2456	Structure	Flue	1.60m wide	1.30m high	East - west aligned flue part of 2448. Constructed entirely of firebricks bonded by mortar and laid in a stretcher bond. Appears to have several cracks in its structure suggesting severe heat affection. Butted by later floors 2466; 2467. One stress fracture is located at the top of the arch and has caused the structure to slump. From viewing the flue within the opening to the west it appears that the structure is elliptical. Although this is difficult to tell as the opening has not been fully excavated and only one third of the flues profile can be seen. However, due to the curvature of the flues profile which can be seen it could be estimated that the flue is elliptical in shape. From viewing the flue two openings to the west a clear profile of the section

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					can be obtained an again appears to be elliptical in shape. Mid upper part of cylinder shows a stress fracture. The flue continues under the eastern baulk of the site.
2457	Structure	Brick Arch	2.40m wide	1.34m high	Elliptical arch way sits over flue structure 2448. The total width and diameter of the arch cannot be ascertained as the profile is partially covered by debris. A stress fracture is visible at the top of the arch and has caused it to slump. This structure is located within flue junction 2624. The arch is slightly disturbed due to the southern side of flue junction 2624 collapsing.
2458	Structure	Brick Arches	2.05m wide (visible)	1.26 visible height	Western facing archway of flue 2456 located in flue junction 2624. a large stress fracture is visible within the arch's ceiling and therefore the ceiling of the arch has slumped. The arch is partially obscured by debris therefore the true estimate as to its width and height is difficult to ascertain. The arch is slightly disturbed due to the southern side of flue junction collapsing.
2459	Structure	Brick Flue	2.70m (visible); 1.92m wide		Brick side flue running off the north side of junction box 2464, constructed of yellow bricks measuring 23cm x 8cm with the three centre rows consisting of bricks measuring 30cm x 12cm. The total length and depth are unknown as it disappears beneath the overburden 2000.
2460	Structure	Flooring/ Jointing around 2459	1.24m long (visible); 0.62m wide		Brick floor/ jointing around 2459. Constructed with yellow bricks on the east side and red bricks on the west side. There is a dividing line between the two types of brickwork- the yellow bricks are probably a continuation of the brickwork surrounding flue 2459 and the red brick is possibly a floor between the flue and brick wall 2506. This is the same as 2461 which is located on the east side of the flue.
2461	Structure	Flooring/ Jointing around 2459	0.50m long (visible); 0.63m wide		Brick/ jointing around 2459. Constructed with yellow bricks on the west side and red bricks on the eastern edge. The yellow brickwork is probably a continuation of the bricks from flue 2459 and the red bricks a continuation of wall 2507. This is the same as 2460 which is located to the west of 2459.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2462	Structure	Flue Head Wall			Flue 2459 head wall, constructed of large yellow brick slabs measuring (on average) 36(?)cm x 9cm x 30cm, and bonded with yellow lime mortar. Appears to have its upper layers of regular size yellow bricks, but this is only still visible on the sides due to damage. It adjoins the north face of wall 2464. It is bonded with walls 2506 and 2507 on either side.
2463	Deposit	Fill of chimney/ flue junction 2464		Unknown as not fully excavated	This deposit consists of mainly collapsed debris from a possible chimney. Covers all three arches which are present within junction 2463.
2464	Negative feature	Chimney/ Flue Junction	2.45m long; 2.27m wide		Rectangular chimney/ flue junction which contains three separate flue arches, one flue arch is present on all the northern, eastern and western sides. This junction box is Fed by three flues, these being 2459; 2456 and 2448. This feature does not been excavated therefore its depth is unknown. The bricks which have been used to construct this feature consists of JB Fisher and Company. The southern side of the structure has slumped causing destruction to arch 2457 and 2458.
2465	Structure	Wall	1.50m long (visible); 0.80m wide	1.50m high	Poorly preserved stretch of wall located to the north of flue 2456 and butting against floor 2466. Mixed construction make up of bricks and roughly shaped stone blocks laid randomly coursed. Continues 1.50m to the east and under the eastern baulk of the site. Appears to be cut by flue 2459. Appears to be on same alignment as wall 2443 and could be that both structures were once one.
2466	Structure	Floor	2.00m long; 1.14m wide		Randomly coursed brick floor 2466 bonded with lime mortar. Butts wall 2465 and flue 2456. Continues under eastern site baulk for unknown distance.
2467	Structure	Floor	2.00m long (visible); 1.20m wide		Randomly coursed brick floor bonded with lime mortar. Abuts flue 2456. Continues under western baulk of site and consists of solely fire bricks.
2468	Group	Brick rectangular bays/walls/ flues	15.1m long; 1.78m wide	0.34m	Series of rectangular vertical channels in a line opening to the north. The south side is the back wall. One surviving complete channel is capped by three larger bricks leaving a rectangular opening against the south face. Differing degrees of vitrification in the bays. System works in conjunction with flues to north linked by a channel that separates them. Bricks yellow coloured refractory brick 250mm x 150mm x 105mm. Base of bays flat. Less vitrification on faces.
2469	Structure	Fe plate in floor 2029	1.74m long; 1.16m wide	0.025m thick	Cast iron plate with central access hatch measuring 0.54m x 0.42m x 0.02m providing access to underlying chamber 2485 and flue 2486. Plate contains four

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
					square openings (0.06m) which are likely to have been used as fixing points for chains/cabling for manoeuvring the plate into position.
2470	Structure	Brick repair to roof of 2448	Detailed on survey (2.4m x 1.2m area)		A brick repair of the roof of 2448. The repair is located at the junction between 2448 and 2447. This area of later brickwork either represents a repair or an alteration to the flues. The visible bricks are refractory bricks and measure 22cm x 8cm x 8cm. The mortar is dark grey as opposed to the pale yellow brown mortar of 2448.
2471	Structure	Walling abutting 2433	0.92m long; 0.62m wide	0.44m visible height	Yellow refractory brickwork remains of springer for flue arch. Bonding of a coal/coke rick grey mortar which has also been applied to much of the wall face obscuring large areas of bonding. Where bonding is visible it is of stretcher bond but it is unclear if the whole wall was constructing using this bond. Wall originally continued further to the north but this has been destroyed. Much of the lower part of the wall is obscured by large quantities of demolition rubble.
2472	Structure	Brick blocking in flue floor 2434	2.04m wide; 1.74m long	0.48m high	Bricks blocking in flue floor 2434. Bricks are stained red/yellow orange. The bricks are at the eastern end of the floor 2434. the brick blocking is to the west of the series of brick bays, where nineteen can be seen in total (group number 2468). The yellow bricks with patching of staining are bonded with grey mortar, which can be seen on a Few of the remaining bricks. Not all the courses of bricks which could be due to the machines when the bricks were uncovered. The entire blockage is made from the same sized yellow bricks with the dimensions being 23cm x 11cm. The brick blockage is stepped, which could be due to damage when the wall was uncovered. On the north side of the blockage with the west facing side, four courses of bricks can be seen, which is 48cm high with the west face covered in vitrified mortar.
2473	Structure	Brick blocking within flue 2448	0.90m wide; 0.24m D	0.90m maximum height	A blocking constructed within flue 2448 comprised of brick and mortar. Into this is also incorporated a ceramic inspection tube laid horizontally. Common brick size in main body larger brick on upper two courses (0.35m x 0.13m x 0.23m). Seems to have been broken on south end and patched by 2474. Measures one brick length/ two brick width. The blocking is set one large brick length in from its west end ie 0.33m.
2474	Structure	Brick blocking	0.60m w (max); 0.40m h (max); 0.30m d		Brick filled blocking as a repair to 2473. a darker mortar used to bond these bricks as opposed to the mortar used in 2473.
2475	Structure	Brick Step	0.70m W; 0.15m H; 0.10m D		A small brick step built into the base of the flue and abutting the blocking 2473. Comprises two half bricks and a single complete brick. Dark grey mortar bonding.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2476	Structure	Brick Built Fill Wall	1.08m H; 0.60m W; Unknown		Brick fill wall between flue 2448 and stone/brick wall 2439. Constructed using pale yellow bricks and similar coloured mortar. Minimum of twelve courses. Abuts 2439. Overlain by wall 2477.
2477	Structure	Brick Wall	0.75m H (as survived); 0.70m W; Unknown		A roughly built brick wall comprising large red bricks (0.45m x 0.20m x 0.36m), standard size yellow bricks and considerable quantities of mortar. The wall is roughly coursed. It does not survive to its full height.
2478	Structure	Brick Flooring	3.1m long; 0.70m wide	0.22m	This feature consists of a red brick floor which has been bonded by lime mortar. It is difficult to decide as to what pattern the bricks have been laid in as the lime mortar has obscured the patterning. This floor has been buried by deposit 2505.
2479	Structure	Brick Flooring	2.00m long; 0.90m wide		This structure is the remnant of a brick floor which had been buried by deposit 2505. It is difficult to try and view the pattern in which the bricks are laid as a layer of white mortar has obscured the patterning.
2480	Negative feature	Channel Outside Bays	14.70m long; 0.32m wide	0.32m deep	This channel was constructed on rubble layer 2505. The purpose of the channel is unknown and runs on an east west alignment. One possible use is that the channel may have carried hot air to Feed into the adjacent bays. The channel has been built upon earlier channel 2490. The base and sides of the channel are dark red from intense heating.
2481	Structure	Brick Base	4.80m long; 1.27m wide		Brick base located to the south of junction 2464 consists mainly of bricks except on its eastern side where stone blockwork has been used to face the base. The bricks are randomly coursed and but brick floor 2480. Bonding obscured by mortar. Bonding consists of grey coal/coke rich mortar.
2482	Structure	Brick and Mortar Base	4.84m long; 2.77m wide	0.67m	Heavily mortared yellow refractory brick and red brick base. Mortar obscures much of the surviving brickwork but it is possible to ascertain that both header and stretcher bonds have been used. Flue channel 2480 runs immediately along the south side of the structure.
2483	Structure	Wall underlying 2443	4.46m x 0.23m		Yellow refractory brick wall surviving to a height of three courses. Bricks laid in stretcher bond on west side and become header bond adjacent to plate 2469. Full extent of wall unclear as it continues beyond both east and west sides of excavation area. Brick dimensions 230mm x 100mm x 65mm
2484	Deposit	Iron Plate	0.47m	0.05m thick	Cast iron plate within wall 2483. Plate potentially deposited within wall fabric to level up coursing. Full width of plate is unclear.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2485	Structure	Chamber	1.56m long; 1.06m wide	1.41m deep	Rectangular subterranean chamber constructed of yellow refractory brick laid in English garden wall bond and bound together with a grey coal/ coke rich mortar. Fifteen courses of brickwork visible. Full depth of chamber is unclear as access not permissible on health and safety grounds.
2486	Structure	Culvert/ Flue	1.54m wide	0.90m high	Culvert/ flue leading from the north side of chamber 2485. access to the structure via a flattened arched opening 0.90m high constructed of yellow refractory bricks in three courses laid in header bond with a matrix of a grey coal/coke rich mortar. The structure extends 0.46m northwards with a height of 0.90m before reaching a brick wall containing a further arched opening with an approximate height of 0.45m. Access not permitted on health and safety grounds.
2487	Structure	Brick Blocking			Brickwork blocking culvert/ flue 2486. Access not permissible on health and safety grounds
2488	Negative feature	Cut in brick floor 2438	0.81m long; 0.38m wide		Cut in brick floor 2438 used to place two courses of stone/ brick in order to keep iron plates 2444on top of flue 2441 in place to cover up an manhole on top of the flue. This cut also cuts into 2438.
2489	Structure	Stone Wall	1.90m long;	1.26m high	Squared random coursed stone wall faced with large to very large rectangular stones part of main north wall of flue bay. Bonded with possible brick doorway 2449 and cut by or part of flue prep (??) 2490. Bonding material same as 2449. Wall was constructed including lower vertical sides of doorway 2449, the arch was constructed, then wall construction continued with 2492/ 2493 as shutter built wall.
2490	Structure	Flue Pipe (Lower)	Unknown		Preparation for flue in main flue bay. May be same as 2478. May be several stages of construction, goes south from wall 2489. Red brick with dark yellow mortar/ lower part of main flue. Same as the rest of flue consisting of multiple stages of construction.
2491	Structure	Structural Backfill Around 2490	0.77m wide	0.54m high	Structural backfill. Part of flue construction in wall 2489. Consists of mainly red brick and hard white mortar. Random coursing some of which extends beyond the line of wall 2484. Lower area of structural backfill part of construction of flue and eastern flue.
2492	Structure	Structural Backfill Around 2449	0.89m wide	0.30m high	Structural backfill over archway 2449/ 245. Random coursed yellow brick soft white mortar construction of wall 2451 after construction of arch 2449. Cut by the construction of tube 2447.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2493	Structure	Structural Backfill Around 2449	1.90m long	0.76m+ high	Structural backfill over archway 2449/ 2489. Random coursed red stone bonded with a soft white mortar. May have been shutter built. Same as 2492 but east of archway 2449 (See back of 2491)
2494	Negative feature	Cut for tube 2447	3.00m long; 1.45m wide		Cut through wall 2451. Cut for the construction of tube 2447. Random cut roughly U shaped with occasional stones from 2451 left in place. Cut for west tube.
2495	Structure	Preparation for tube 2447	0.90m wide	0.97m high	Yellow brick preparation for tube 2447. Backfills cut 2491 and consists of ten plus courses of headers bonded with a soft yellow mortar (see back of 2494). Similar to brick base 2478 to east in gap between main flue and north wall (may be same thing). Preparation for tube 2447 involves filling in the cut and constructing a square linear box shape at the right angle into which the lower half of tube 2447 can be constructed
2496	Structure	Collar Around Tube 2447	0.42m wide	0.73m total	Yellow brick collar over the top of tube 2447 intended to support the upper part of wall 2451. Abutted by tube cover 2497. To south wedge shaped bricks with hard cream mortar, two courses of bricks wedge shaped outer (see back of 2494).
2497	Structure	Cover of Tube 2447	1.89m long	0.50m high	Yellow brick cover of tube 2447 intended to seal the heat in and support the upper section of the rebuilt wall 2451/ 2489. Three courses of bricks near collar.
2498	Structure	Backfill over Tube 2447	1.60m long	0.35m high	Structural backfill over the cover of tube 2447, repairing wall 2451 after the construction of tube 2447. Random coursed stone and brick and bonded with a hard white mortar may have been shutter built. (See back of 2494) Abutted by rubble backfill 2505
2499	Negative feature	Cut for Tube 2453	2.47m (?) wide	1.32m high	Cut through wall 2489. Cut for the construction of tube 2453. Random cut, roughly U shaped with occasional stones from 2489 left in place. Cut for east tube.
2500	Structure	Structural Preparation for Tube 2453	1.20m wide	0.70m high	Yellow brick preparation for tube 2453. Backfills cut 2499 and consists of six courses of headers bonded with soft yellow mortar. (See back of 2499). Preparation for tube 2453 involves filling in the cut and constructing a square linear box shape at the right angle into which the lower half of tube 2453 can them be constructed.
2501	Structure	Collar around tube 2453	0.42m wide	0.75m total	Yellow brick collar over the top of tube 245. Intended to support the upper part of wall 2489. Abutted by tube cover 2502 to south. Wedge shaped bricks with hard cream mortar. Two courses of bricks under wedge shaped/ outer all headers. See back of 2499
2502	Structure	Cover of Tube 2453			Yellow brick cover of tube 2453. Intended to seal in the heat and support the upper section of the rebuilt wall 2451/ 2489

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2503	Structure	Backfill over tube 2453			Structural backfill over the cover of tube 2453 repairing wall 2489 after construction of tube 2453. Random coursed stone and brick bonded with hard white mortar may have been shutter built (See back of 2499). Abutted by rubble backfill 2505.
2504	Structure	Blocking of Possible Doorway	0.86m wide	0.55m high	Blocking of arched doorway 2449. Consists of red brick and occasional stone bonded with hard white mortar roughly coursed constructed upwards and not quite reaching the top of the arch. Possibly constructed from north side with occasional small voids (see back of 2489)
2505	Deposit	Rubble Backfill Between Wall 2451/ 2489 and *			Rubble fill between main flue and north wall 2451/ 2489. Constructed of grey mortar lumps and fragments with frequent brick fragments (both red and yellow) and occasional stone fragments, occasional area of dark soil/ charcoal deposits. (See back of 2490). Rubble backfill on top of red brick base 2478, between main flue and north wall 2451/ 2489. Brick base 2478 may have been an attempt to backfill gap and possibly form part of the preparation under tube 2447 to the west. This deposit filled in gap between tube 2447 to west and 2453 to east and formed the foundation for hot air channel 2480. In the centre the where the north wall of the main flue has partly collapsed. Removed during machining causing partial collapse of channel 2480 between tubes 2447/ 2453
2506	Structure	Brick Wall Adjoining 2443 and 2462	1.24m long	0.82m high	Red brick wall located on the west side of flue 2459 and flue head 2462. It is butted against the build-up of floor 2446 and adjoins the corner of 244. There is an equivalent wall on the east side of the flue and flue head. It is connected with floor 2460 and is possibly continued by it
2507	Structure	Brick Wall Adjoining 2462	0.49m long	0.56m high	A red brick wall running north - south on the east side of flue head 2462 and flue 2459. an equivalent wall is 2506 which is on the west side. It is adjoining floor 2461, and possibly continues by it.
2508	Structure	Brick Strengthening/ Repair	3.00m long; 0.40m wide	0.60m high	Up to eight courses of heavily vitrified purple brown brick (220mm x 105mm x 75mm) built into the exterior of the outer flue wall 2436. Corresponds with the vitrified chimney. Brick not refractory indicated by degree of melting which includes the mortar. Possibly/ probably in place near the back wall of the chimney replacement. Temporary emergency measure! Followed by later upper level 0.37m internal floor level of flue to uppermost surviving course. Back of 2436 made to fit slight curve of 2508 leaving a void between them.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2509	Negative feature	Chimney position	2.49m north - south; 1.83m east - west	Unknown	Likely position of chimney - not proven. Indicated by square shape and infilling
2510	Structure	Masonry Wall	16.00m long; 1.40m wide	0.50m deep	1880s. Sandstone wall bonded with hard grey mortar containing limestone flecking and isolated coal flecks. The south elevation is neatly dress - to be seen! The north undressed - hidden! Built in courses. Core similar stone randomly placed to a broad plane- not just thrown in. Similar mortar filling voids in core- very Few actual voids. Stone sizes 0.40m x 0.40m x 0.25m to 0.45m x 0.40m x 0.10m
2511	Structure	Masonry Wall	3.20m long; 0.90m wide	0.60m+ high	1880s. Sandstone wall with a step in on the west side. Bonded with hard grey mortar with lime Flecks and coal flecks. No elevations dressed. Core of smaller angular stone construction to north but cut by pipe trench 2517 the same wall. Possibility that wall 2512 is contemporary. Stone dimensions 0.30m x 0.30m x 0.15m to 0.20m x 0.20m x 0.10m
2512	Structure	Brick Walling (1880s)	18.4m long; 0.47m wide	0.27m+ deep	Wall of yellow brick laid alternative header and stretcher bonded with hard very dark grey mortar with coal flecks. Corner overlaid with brick foundation wall 2529 *North elevation probably edge of chimney* Bricks 0.22m x 0.11m x 0.07m/0.075m. Possibility that 20512 contemporary with 2511.
2513	Structure	Brick Wall	2.20m long; 0.75m wide	0.30m + deep	Brick wall comprised of red and yellow coloured brick bonded with hard grey mortar with lime and coal flecks. Alternate header and stretcher courses. North elevation internal edge of chamber/ room. This wall doesn't line up with 2512. Possibly wall 2511 at height would have been a substantial barrier and therefore there was no relationship between them. Brick dimensions 210mm x 100mm x 75mm
2514	Structure	Brick Wall	0.50m long; 0.75m wide	0.15m + deep	Yellow and red brick wall bonded with hard grey mortar - return wall to north of 2513. East face internal elevation of a chamber likely.
2515	Structure	Brick Wall	0.90m long; 0.35m wide	0.10m+ deep	Yellow and red brick wall, same as 2514 but cut by pipe trench. Red brick on inside face, also intended face to chamber.
2516	Structure	Brick Wall	2.24m long; 0.60m wide	0.10mn deep	Red and yellow brick wall, south elevation chamber edge- internal. Wider than its partner wall 2513. Brick regular size is 210mm x 100mm x 70mm. Bonded with hard dark grey mortar with coal flecks and lime flecks. Alternate header/ stretcher courses. 2547; 2570

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2517	Structure	Masonry Wall 1880s	1.30m long; 0.90m wide	0.10m+ deep	Masonry walling, identical to 2511 but cut by pipe trench. Sandstone wall bonded with hard grey mortar with coal flecks and isolated lime flecks. Stone size 0.40m x 0.30m x 0.08m. Mortar laps up to 2539 (2578) so a much later phase. Possibly contemporary with 2518
2518	Structure	Brick Walling 1800s	1.87m long; 0.54m wide	0.25m+ deep	Yellow brick walling parallel to and partner of 2512. Alternate header and stretcher coursing. Side wall of probably chimney. Mortar hard grey with coal flecks and isolated lime flecks. Stone from 2539 overlying brick
2519	Deposit	Rubble Fill	1.84m long; 0.55m wide	0.30m + deep	High ash content and clay containing fragments of red brick at all angles of repose. Large ones, small regular brick sizes 0.25m x 0.15m x 0.11m to 0.11m 0.08m x 0.07m. Very gritty texture. Bricks reused from somewhere. Possibly dumped. Infilling from chimney.
2520	Deposit	Rubble Infilling			Gritty ash fill with little clay binding as 2519 but a difference in colour. Various brick and stone reused to pack out the void - all broken fragments. Mostly red brick but isolated yellow, some with holes through (0.35m x 0.20m x 0.10m), stone 0.30m x 0.30m x 0.10m to broken stone or brick sizes. Infilling chimney possibly.
2521	Structure	Rubble Brick Blocking	1.80m long; 0.40-0.15m wide	0.35m + deep	Un-mortared random sized brick laid to courses to form a blocking within chimney. The line is not quite straight but an attempt has been made to make it so. Depth behind the elevation variable depending on the size of the brick used, butted together blocking 2522. Similar on opposite side.
2522	Structure	Brick Rubble Blocking	2.20m long; 0.40m - 0.20m wide	0.20m+ deep	Irregular line of reused brick to form an edge to block chimney position and drain pipe backfill. Comprised of mostly large red brick fragments (0.38m x 0.15m x 0.10m) and regular brick all laid on bed. No mortar butted together.
2523	Negative feature	Pipe Trench Cut	10m+ long; 1.20m wide	Unknown	Cut, trench for ceramic pipeline. Uses line of the flue where it can but cuts through structures where necessary.
2524	Structure	Pipeline	16m+ long		Brown glazed ceramic pipe 8" (0.20m) collar 10" in 3ft lengths. Concrete haunching around the pipe in flue- not known if supported like this throughout. Haunching 0.50m - 0.60m width
2525	Structure	Brick Rubble Blocking	1.45m long; 0.25m wide	0.35m high	Series of large reused bricks, laid to courses to form an edge against flue 2526 and chimney position. Bricks laid over the pipe haunching. The build doesn't seem to appear to be as sound as 2521/2522. No mortar butted together. Definitely later than the east/ west blocking.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2526	Negative feature	Flue			Brick built oval flue (1.51m) wide Height lost and base blocked with concrete. Length 5m +. Flue brick shows signs of vitrification indicative of heat intensity. Flue continues to the east probably from a chimney position.
2527	Structure	Arched Brick of Flue			Yellow refractory brick laid to form an oval opening to produce a flue. Two different bricks used, the lower ones below midpoint of horizontal are smaller and laid in two courses, whilst the upper bricks are large covering both small and tapering to form an arch overhead. Mortar hard pinkish brown- clean.
2528	Structure	Flue Walling	Length 5m+		Yellow refractory brick laid to courses to form an arch/ funnel structure. Change to the of 2527 occurs where secondary flue 2555 occurs. The brick here is bespoke to form a cradle within a circle i.e. at right angle to the original line (Timmis & Co Stourbridge) Pattern with alphabet notation used for brick selections. Pinkish brown mortar - clean.
2529	Structure	Brick Walling (Outer Wall of Flue 2526)	See Sketch		Yellow brick wall bonded with soft greyish white mortar (lime?). Alternating header/ stretcher coursing on exterior. Inner brick laid to follow curve of arch 2527. This width expanding to north as wall runs. Standard sized bricks. 1.55m length exposed probably continues 5m+ Starts at flue/ chimney division.
2530	Negative feature	Pit	3.6m (NE-SW); 3.6m wide	Unknown	Irregular shaped but tending to rectangular pit cut through masonry walling. Modern intrusion possibly as recent as this work programme.
2531	Deposit	Rubble Deposit with Clay	5.4m long; 0.70m wide	Unknown	Infilling of clay and stone and brick rubble between flue wall and masonry wall. Randomly deposited stone and brick amongst gritty coal, clay and mortar. Not known if in situ whilst flue in operation.
2532	Deposit	Rubble and Clay Infilling	2.00m long; 0.70m wide	Unknown	As 2531- cut by 2530 but otherwise both are part of the same fill. Not many yellow bricks from the flue within the fill.
2533	Structure	Masonry Walling 1880s	2.10m long; 1.10m wide	Unknown	Pinkish red sandstone walling bonded with pink/white gritty fairly hard mortar with coal flecks and lime mortar. Core of wall similar stone laid flat to best fit and mortar making up the difference. Exterior edge, not dressed but it appears that is selection to form a 'fair face' Fairly large stone throughout 0.40m x 0.30m) to 0.30m to 0.20m
2534	Structure	Masonry Walling	5.00m long; 1.00m wide	Unknown	Same as 2533, cut by 2530. Major difference is that larger reddish boulders have been used but in an isolated patch to the west side but which also intrudes into the added outer skin 2538- This build doesn't fit the neatness of the general line ? A rebuild/ repairs. However grey mortar bond as with all of the outer skin. All angular stone.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2535	Structure	Masonry Wall/ Floor 1880s	1.20m long; 1.00m wide	Unknown	As 2534. Appears to be filling the space between 2542; 2543 and 2540 but constructed to the same standard as 2534. The line continues through to 2536. It is difficult to see as these floors/walls could have been put in before the brick- They might be infilling a square void.
2536	Structure	Stone Walls/ Floor	1.20m long; 1.10m wide	Unknown	Similar to 2535 and on the same line but supported by brick flooring 2542; 2543. Possibly contemporary which is easiest to build together. If adaption then difficult to slot brick between irregular stonework.
2537	Structure	Masonry Walling	2.10m long; 0.96m wide	Unknown	Pinkish red sandstone walling bonded with light grey mortar with coal flecks. Smaller stone than 2533, core has cobbles as well as flat angular stone but isolated cobbles. Stone size 0.25m x 6.2 x 80mm average. Additional stone butted to earlier wall 2533.
2538	Structure	Masonry Walling 1880s	5.00m long ;0.70m wide	Unknown	Same as 2537 but stone larger (0.40m x 0.30m)
2539	Structure	Stone Wall/ Flooring 1880s	1.20m long; 0.75m wide	Unknown	Sandstone floor/ wall with light grey mortar. One stone overlies 2518. Part of stone and earlier brick 2540. * Without resorting to excavation the sequence cannot be fully resolved
2540	Structure	Brick Edging	2.02m long; 0.235m wide		North - South aligned brick feature between masonry 2538 and 2534 to the west and 2539 and 2535 to the east. Grey mortar. Two courses in height exposed but the northern half is damaged so only one course is exposed possibly needed repairing along with wall 2538 as the northern part has lines of pink mortar like 2534 and southern half was grey mortar like 2538
2541	Structure	Brick (Large) Flooring/ Infill	1.10m long; 0.84m wide		Red bricks in different sizes seem to be a base for a brick floor to go on top perhaps? Unknown function, but some of the bricks are large (30cm x 23cm x 9cm) and form an east - west linear platform. Could be infill? Some burnt patches, but no vitrification. Bad state of preservation. Contains soft white mortar.
2542	Structure	Brick Structure/ Base	1.17m x 1.56m		A layer of brickwork which is heavily mortared on top, suggesting and the layer of brickwork may have gone on top. Mixture of red and yellow bricks measuring 22cm x 10.5cm x 5cm. Possible machine base layers of bricks could have absorbed vibrations and heavily vitrified brick to the west. Grey mortar.
2543	Structure	Brick Base/ Floor	1.70m x 0.85m		Area of brick floor/ base similar to 2542 but to the north and the mortar suggests its earlier. Two courses visible. Mainly red brick measuring 22cm x 11cm x 7cm. Pink/white mortar.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2544	Structure	Brick Base/ Floor	3.60m long; 0.83m surviving width		All yellow brick except one red brick (infill?) Floor? Most has been destroyed exposing lower layers 2542 and 2543. Runs the length of the flue. May have had at least two courses of brick base above it which is butting against flue 2555 and 2545.
2545	Structure	Flue Collar	3.60m - 3.70m l; 0.50m - 0.60m h (see comment box)	0.15m deep	A north- south linear, convex collar/ external layered brick work of flue 2555. Bricks are a mid-yellow orange in colour, with mortar same colour with flecks of charcoal. It is unclear towards the south whether these are additional layers added later on or whether it is the layers on the north end that has been lost. It is unclear how many layers originally made up the 'collar' of the flue 2555. Collar rests on platform of layered brick surfaces spreading to the west of the site 2544. The collar is a light red in colour at the northern end (c.0.60m) and changes to a green/yellow colour (c1.10m), with the remaining colour consisting of mid orange brickwork (c1.70m) towards the south.
2546	Deposit	Fill of 2530	4.30m x 3.00m approximately		Black brown deposit of mortar; charcoal; possible contamination (smell). A lot of steel rods, concrete blocks, brick and stone dumped between cut 2530. Possibly from the electrical Old Thorn Site.
2547	Deposit	Pipe Trench Backfill			Mortar, charcoal, ash and rubble (brick and stone) backfill. All within walls 2513.
2548	Structure	Yellow Brick Flue Wall	12.00m long; 0.33m - 0.32m wide	Unknown due to limits of excavation level	East - West aligned linear of flue wall, no evidence visible for the arched part of the wall (unlike 2549)
2549	Structure	Yellow Brick Flue Wall	12.00m long; 0.35m wide	Unknown due to limit of excavation level	An east - west linear forming flue wall. Bricks are yellow in colour. Towards the western end of the structure measuring c.6.60m long x 0.35m wide, the wall appears to be forming an arch, with brickwork sloping up towards the south.
2550	Structure	East - West Flue	c.11.5m long; 2.00m wide		Brick lined flue (yellow brick) which is east west aligned and a continuation of the flue from the main excavation. In other parts of the site this kind of flue has had a rounded base, but here it is not excavated to full depth, so there is no proof this is the same. Two courses of yellow fire brick line the north and south walls 2548; 2549. Five pillars or bases 2551, which are highly vitrified are within the centre of the flue and the east end of the flue is blocked by brickwork 2552

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2551	Structure	Five Brick Pillars in Flue 2550	0.37m long; 0.37m wide	Height unknown	Five pillars each measuring 0.37m x 0.37m in length and width. Some pillars in bad state of preservation. All bricks heavily vitrified. Brick pillars further east are more heat damaged than the western pillars. Five bricks make up each square pillar in plan. Each brick 23.5cm x 11cm x 6.5cm. All bricks have fractured/ broken and are very brittle due to heat damage.
2552	Structure	Brick Blockage of Flue 2550			Red brick wall aligned north - south blocking the eastern end of flue 2550. It butts up against walls 2548 and 2549. It seems to have been roughly made. Mortar is very visible and not well applied, but the colour of mortar is no longer original as it has been heat affected. Not excavated to full depth. Three courses visible. Laid with headers showing only. Bricks 23.5cm x 11cm x 6.5cm. Bricks are same size as bricks in 2551- possibly contemporary. Not many bricks on the site match this measurement and this is a more modern measurement. - machine made bricks. No stamps. Possible repairs?
2553	Structure	Brick Base with Recess	2.05m long; 0.42m - 0.40m wide	Unknown	A dark yellow brick base with two recesses. Linear in form running north to south. Majority of bricks are laid east to west and are approximately 0.24m x 0.12m in size. Depth unknown due to limit of excavation level. Mortar same colour as brick with stone/ lime inclusions, very hard consistency. The eastern extent possibly abuts against 2554 or may be contemporary with 2554. Appears to be some kind of fill between 2553 and 2554. Unclear whether 2553 has cut into 2554 or whether 2554 was constructed after 2553 with the thin band of 2554 being final packing between 2553 and 2554 ?
2554	Structure	Brick Floor/ Base	3.35m long (E-W); 2.00m wide (N-S)	Unknown	A mid yellow brick floor base of which three layers/ heights of floor are visible. Bricks have been laid down in and east to west orientation (length ways). The floor has surviving upper layers towards the east side (height increases by one row of bricks). The depth of the floor/ base is unknown due to limit of excavation level. Mortar is same colour of bricks (mid yellow), hard consistency with small stone inclusions and charcoal flecks <1mm
2555	Structure	North - South Tunnel Flue	3.60m long; unknown width	Unknown	Blocked at the southern flue exit, yellow brick and has collar for support around centre 2545. See 2556 for detail of entrance. Rounded flue, white mortar, heavily vitrified at the exits.
2556	Structure	Brick Blocking Flue 2555	0.80m wide;	0.70m high (visible)	Mix of red, yellow and reused heat affected bricks used to block flue 2555. No mortar binds the bricks. The flue is circular and the bricks used to block it are rectangular, so it is not well blocked up.

Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2557	VOID				VOID
2558	Structure	North - South Aligned Rectangular Flue	1.15m long;	0.64m deep	Six courses of brick survive in height. The flue is north - south aligned. The flue is rectangular inside measuring 0.32m (W) x 0.40m (H). Large brick blocks cap the flue. The west facing section is the only visible section and the bricks are damaged. All bricks are yellow brick with some vitrification near mouth of flue. Bricks have all mainly discoloured to a deep brown red due to heat exposure, but the only actual vitrification is at the base to the west of the flue. This brickwork may have had frequent repair due to high levels of heat. The floor is very vitrified whereas the brickwork is not, so many have been repaired. The brick walls also have a more modern brickwork, possibly post 1900. All bricks are firebricks. The flue has a brick base which ends and fill has built up so no base is visible at this exit.
2559	Structure	Remnant Chamber Base/ Vitrified Surface	0.95m long (E-W); 0.30m wide (N-S)	0.02m - 0.08m deep	Slag base of possible chamber with mixed dark red vitrified brick. Surface is irregular, brick only noticeable on eastern extent. Possible remnants of chamber base situated within brick floor/ base 2554. Appears to be associated with 2557 and vitrified patches 2560 and possibly 2561.
2560	Structure	Possible Remnant of Chamber Base Vitrified Surface	c.1.10m long N-S; 0.40m wide E-W		A north-south linear patch of vitrified/ burn brick with remnants of slag at base of burning (dark red brick). This overlies floor/base 2554 of which this patch of burning/ base is located on level two (see sketch of 2554). This is a thinner layer c.0.5m x 1.00m in depth, compared to 2559 and 2557.
2561		Possible Remnants of Brick Chamber/ Burnt Patch	1.30m - 1.40m x 0.75m	0.02m deep	A pale pink/ white staining or possible remnants/ material associated with vitrified chambers 2559 and 2560. It appears that this may continue beneath level two (see sketch on 2554. Mortar is same colour and charcoal rich inclusions <1mm in size. It is only associated within boundary. Length of 2559 the staining disappears to the north in which the mid yellow bricks of 2554 resume (see sketch on 2554).
2562	Structure	Yellow Brick Base	940mm long; 470mm wide	2 brick courses exposed	Rectangular yellow brick, grey lime mortar bond, possibly column base. Well-made compared to adjacent 2563. No clear foundation cut in 2566, suggesting pre dates formation of deposit 2566. Bricks 230mm x 120mm x 80mm.
2563	Structure	Isolated Linear Brick feature			Small linear east west aligned brick 'base' parallel to southern elevation of rammer wall 2510. Mainly yellow brick with two red bricks. Mid grey lime mortar. Slopes slightly downhill to the west. Demolition material? Simple temporary base?

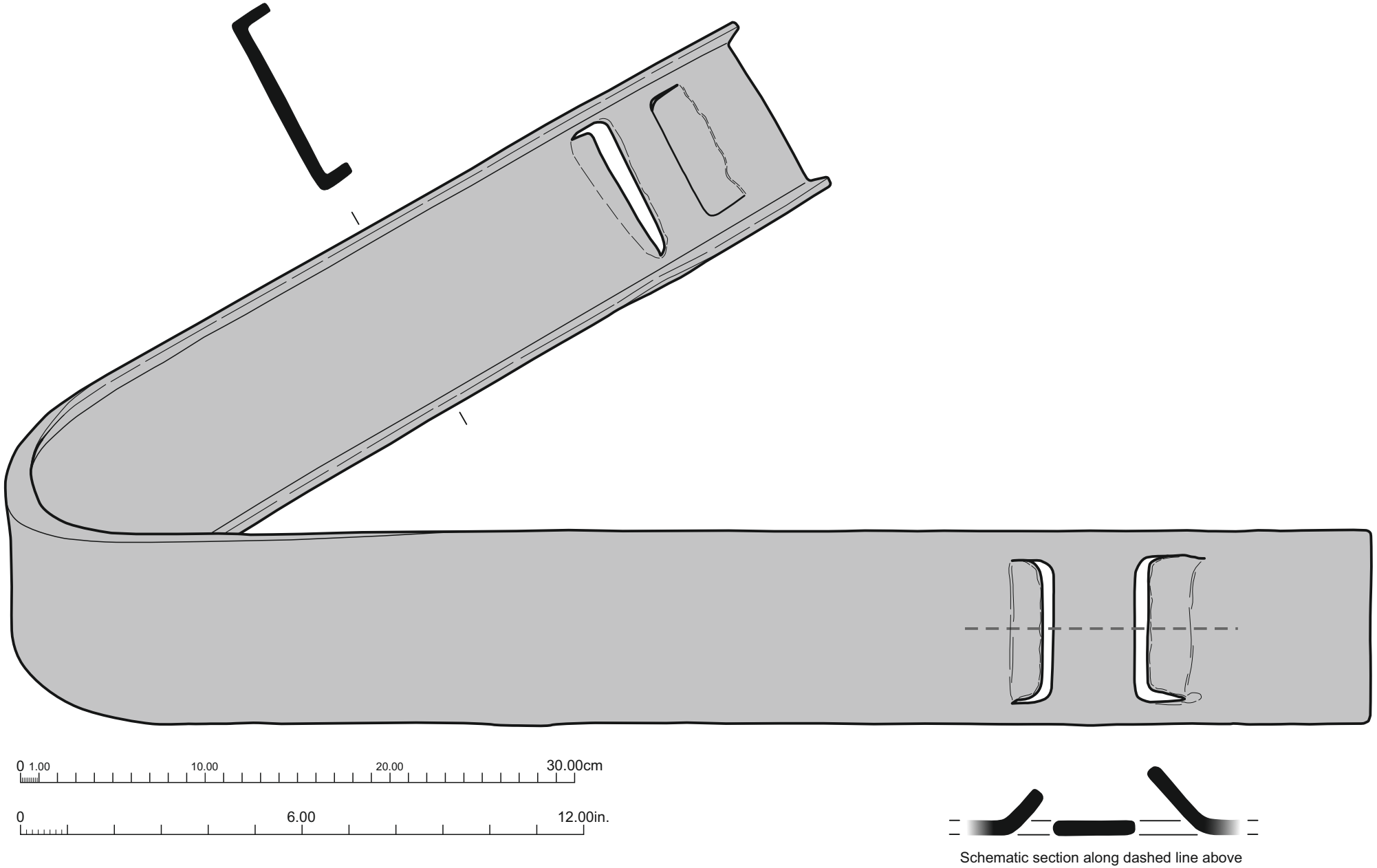
Context	Form Objective	Form Subjective	Dimensions	Depth	Description
2564	Object	Fe object in coal deposit south of wall 2510	270mm long; 110mm wide	8mm thick	Corroded slightly curved iron plate/ strap element. Sits in deposit 2566. Lies in close proximity to 'features' 2562 and 2563
2565	Object	Fe Object	285mm long; 90mm wide	9mm thick	Curved iron plate/ strap. Corroded. Lies in deposit 2566 on south side of Feature 2563. During machine excavation cables and tubing were noted coming off this and possibly within the deposit, parallel to and close to south elevation of rammer wall 2510.
2566			Covers most of area south of rammer wall 2510	Depth	Matrix of fine 'silty' coal dust with some firm brown silty brown. Small fragments of construction material waste. Very similar in appearance to the old working surface noted in main excavation.
2567	Deposit				Brownish red silty clay (possibly heat affected). Matrix for sub rounded cobbles. Truncated by Thorn Works construction/ demolition. Either backfill of construction cut for brick feature 2529, or more likely demolition deposit associated with demolition of coke oven complex.
2568	Deposit	Rubble Over 2510			Red ashy sandy matrix. Red oven brick rubble material dumped over south elevation of rammer wall 2510. Overlies fine coal waste deposit on south side of rammer wall 2510. Upper portion of deposit truncated by Thorn Works construction/ demolition activity.
2569	Deposit	Fil between rammer wall and S wall boiler house			Backfill deposit of brown yellow grey sandy clay loam between rammer wall 2510 and 'boiler house' wall 2512. West limited by boiler house wall 2511. East limit unknown, cut by tank east limit. Contains fragments of yellow brick, lumps of grey lime mortar and coal fragments.
2570	Deposit	Redeposited Material (late 19thC)	10m long (E-W); 3m wide (N-S)	Unknown	Yellow sandy clay, redeposited natural on north side of rammer wall 2510. West of 'boiler house' wall 2511. Cut by modern 20thC pipe trench 2523.
2571	Structure	Brick Wall North of 2549	0.40m wide	0.20m deep	A small portion of north south aligned yellow brick wall bonded at a right angle to the north wall of the east west aligned flue wall 2549. Part of the wall is damaged so the bricks are stepping. Four courses high exposed, two bricks in width exposed.
2572	Deposit	Sandy clay overlying 2571; 2549; 2558	1.70m long;	0.03m - 0.30m deep	Mid brown sandy clay overlying structures 2571 and 2549 and the northern most 0.75m of flue 2558. Occasional, rounded stones (1mm-10mm), one isolated stone at 60mm diameter. Some flecks of charcoal.

Appendix II Catalogue of illustrated metalwork

Table 6. Objects recommended for illustration from Dr Tim Young's metalwork report and the steelmaking ceramic report

Drawing number	Reference	Description
1	225 315-316 railway sill	steel narrow gauge railway tie for flat bottom rail, 1210mm long, folded up from slots 100-125mm and 175-190mm from end would take maximum 80mm width base; 105mm x 4mm main section but sides folded down to 18mm below top. Suggests flat bottomed rail of 60-65mm width and gauge of 890mm
2	226 305-307 railway chair	chair for narrow rail, slot 90mm wide at base, expansion 35mm deep, then 65mm wide for top 40mm or 85mm deep. 355mm x 110mm base, slightly sigmoidal with offset holes, fastened by bolts or spikes, tip not seen, 170mm preserved 18mm diameter, 35mm domed head 11mm tall
3	241 227-229 plateway rail	3 foot long, entire, chair 130x50mm with two raised bosses on inner side, base of rail shows recess below rising section, 30mm thick flange on outer face, riser 72mm off base at ends, 100mm in centre, flange has inset 45-85mm from outer edge, about 5mm deep, crest of riser is 25mm inside inner edge of chair, rail 115mm wide in centre, no fixing holes visible
4	242 379-382 scrap pile channel rail fragment	725mm long piece, width 120mm, chair 140mm x 85mm, slight rounded lump extends on wide, lower face has central, 25mm wide, 5mm high, crenulated sides, 15mm thick typically on vertical, wider at base, channel 80mm, sides c. 40mm high, badly damaged, accreted.
5	244 308-309 2306 plateway sill	horned sill, 830 mm centre bar, 160mm to tip, 45mm x 45mm 'D' section; lotus head 230mm long, 110mm wide, upturned tip as outer cheek, inner horns do not survive, head 20mm thick
6	245 366-371 sleeper block	thin stone slab, 550 long y 390 wide maximum thickness 72mm. Impressions visible of the integral chairs. Chair 1 75 wide 140 long, second is 74 wide and fades out at 125. iron spike head is 35mm x 18mm, 30mm proud, section where disappears into stone is about 16 x 11mm. method of securing into stone is not known, hole must be very small and does not extend through
7	246 WB Cast iron wheel	Cast iron wheel, 750mm diameter, 50mm wide, hub 75mm diameter extends 35mm out on one side, axle hole c.35mm but obscured, 8 spokes
8	247 283-285 five spoked wrought iron wheel	with attached short stub axles, possibly from wheelbarrow? marked 'PERKS WROUGHT IRON WHEEL LYE.. PAT No. 18595', on possible enamelled or plated 'hub'. 40mm x 8mm rim section, 14mm diameter spokes, hub in two halves total 30mm thick, axle swells to hub one side, not the other, suggesting means of 10assembly; 65mm protrudes each side of the hub which is 82mm diameter
9	267 297-298 2066 spanner	open-ended spanner: 425mm long, shaft 350 and 30mm x 20mm section, gap is 33mm
10	268 297-298 2241 spanner	open-ended spanner: 560mm long, 20mm diameter, gap 50mm, head 22mm thick, bent in slight S form
11	271 291-292 wrought iron tool	: 950mm long tool, small suspension loop and large curved hook, 13mm diameter, hook 130mm across 55mm return, loop 60mm o/d, 32mm i/d
12	272 293 2132 Hooked long tool	wrought iron tool: 1120mm long hook tool, 15mm diameter rod, 112mm x 85mm outside handle, 83mm x 50mm inside, short spikey hook turns 55mm
13	273 WB (in trough) prise bar	with sigmoidal flattened tip (cf smiths tongs),625mm long, 530mm of 22mm diameter, flattens down to 45mm long basal surface widening tip 25mm wide inclined at 10 to shaft
14	276 296 cold chisel	: 320mm long, 60mm diameter, tapering to 60mm wide edge

Drawing number	Reference	Description
15	278 350-351 u/s mandrel:	half a mandrel, 225mm long, representing half of original c.410mm, cheeks 30mm, square section close to eye 20x30mm, hole would have been 60mm long
16	287 327-331 cast iron hinge plate	Overall length 1390mm long, 1280mm on edge away from protruding lugs, which are 110mm wide, main part 162mm wide, 17 rivets down each long side, lugs have holes 30mm x 20mm, adjacent to part with lug are raised loops one with 67mm pin extending, pin 24mm diameter, loop external diameter 45 mm. Raised edges of plate are 40mm wide along line of rivets 43mm deep. (fitting from early coke oven??)
17	288 281-282 2362 structural iron	Fastening for bar from wall in oven. Cast iron bar with terminal loop, 155mm x 45mm bar section, 480mm surviving, snapped end, 200mm long x 260mm wide head with 50mm x 145mm slot, inner long face of slot is coincident more or less with remains of attached brickwork
18	357 333 copper alloy plate	Almost square 440x460mm, 11mm thick; 9 holes on long side, each 18mm diameter not quite evenly spaced, on shorter side 2 threaded holes 19-20mm, third threaded hole in other corner; has attached strap 250mm long, 37mm wide, 2mm thick, free end folded back 80mm, riveted to min piece at inner end
19	Type 1 Tuyére	Most complete example, although it has been used. 240mm in length and widening from 155mm in diameter to approximately 160mm above the flared base, which itself has a diameter of 190mm. Pattern of nine bores.
20	Type 2 Tuyére	Largely intact example being 227mm long and 140mm in diameter. Pattern of nine bores.



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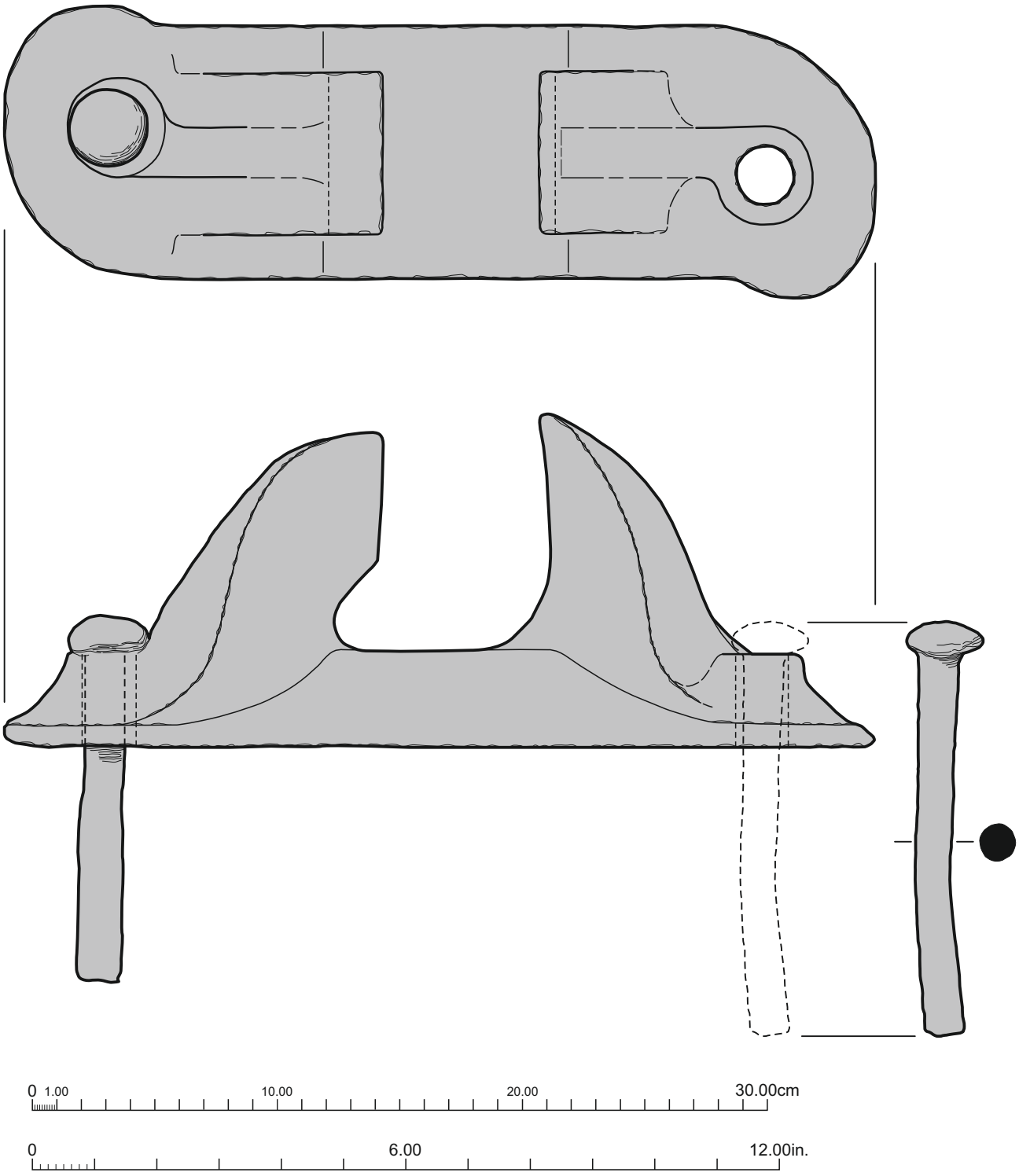

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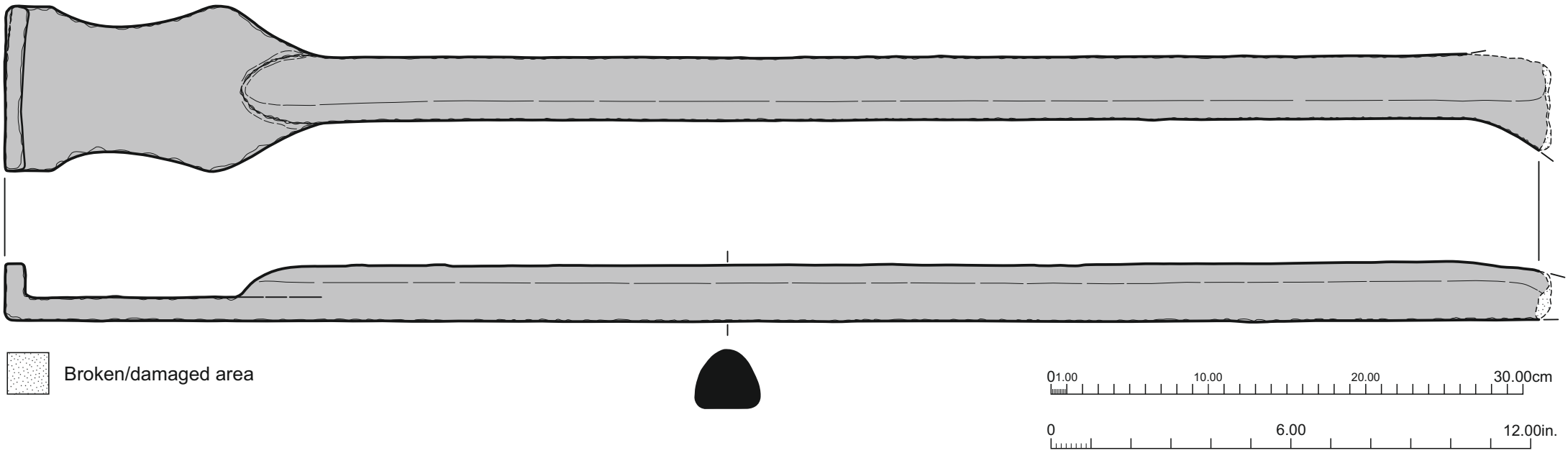

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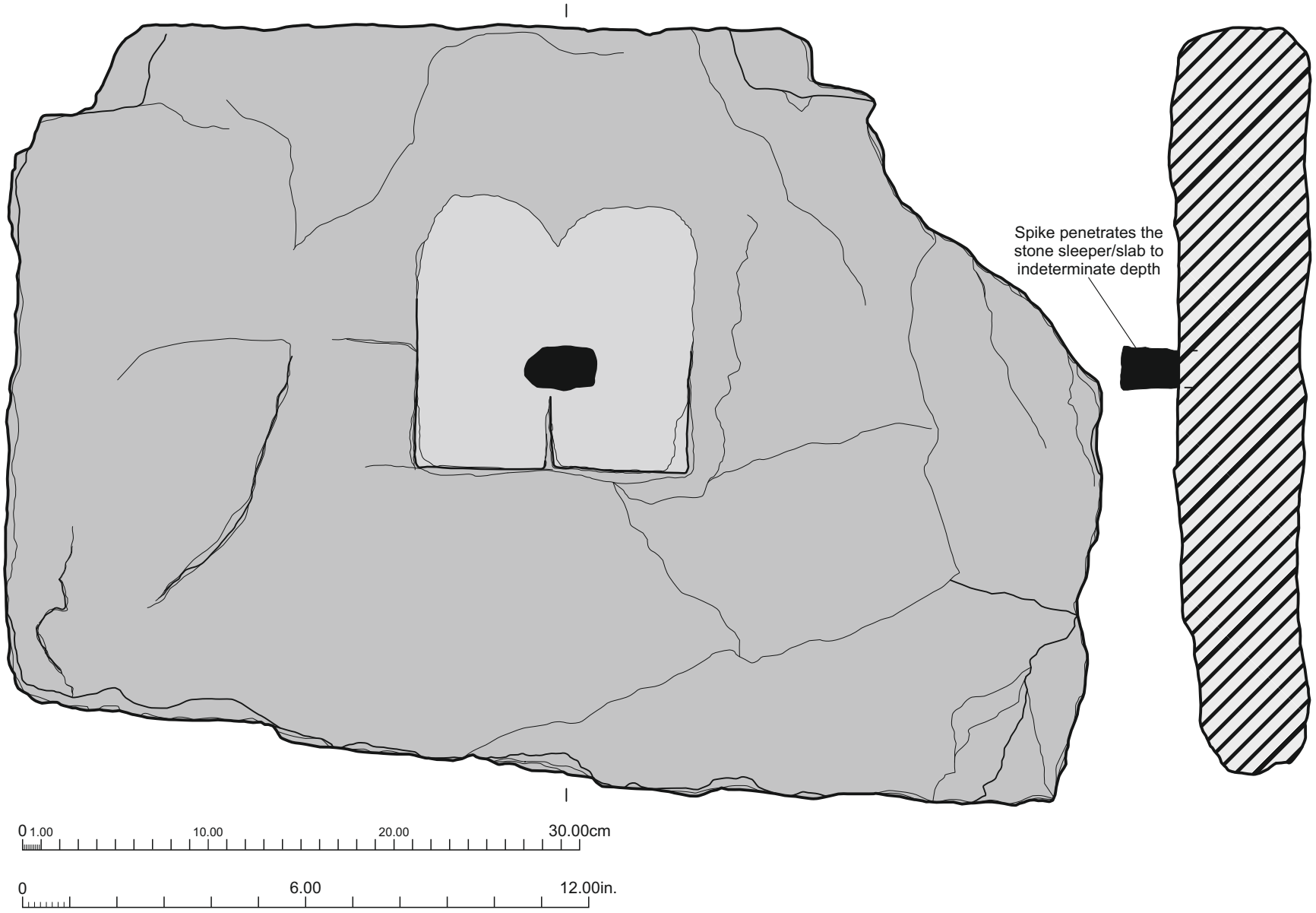

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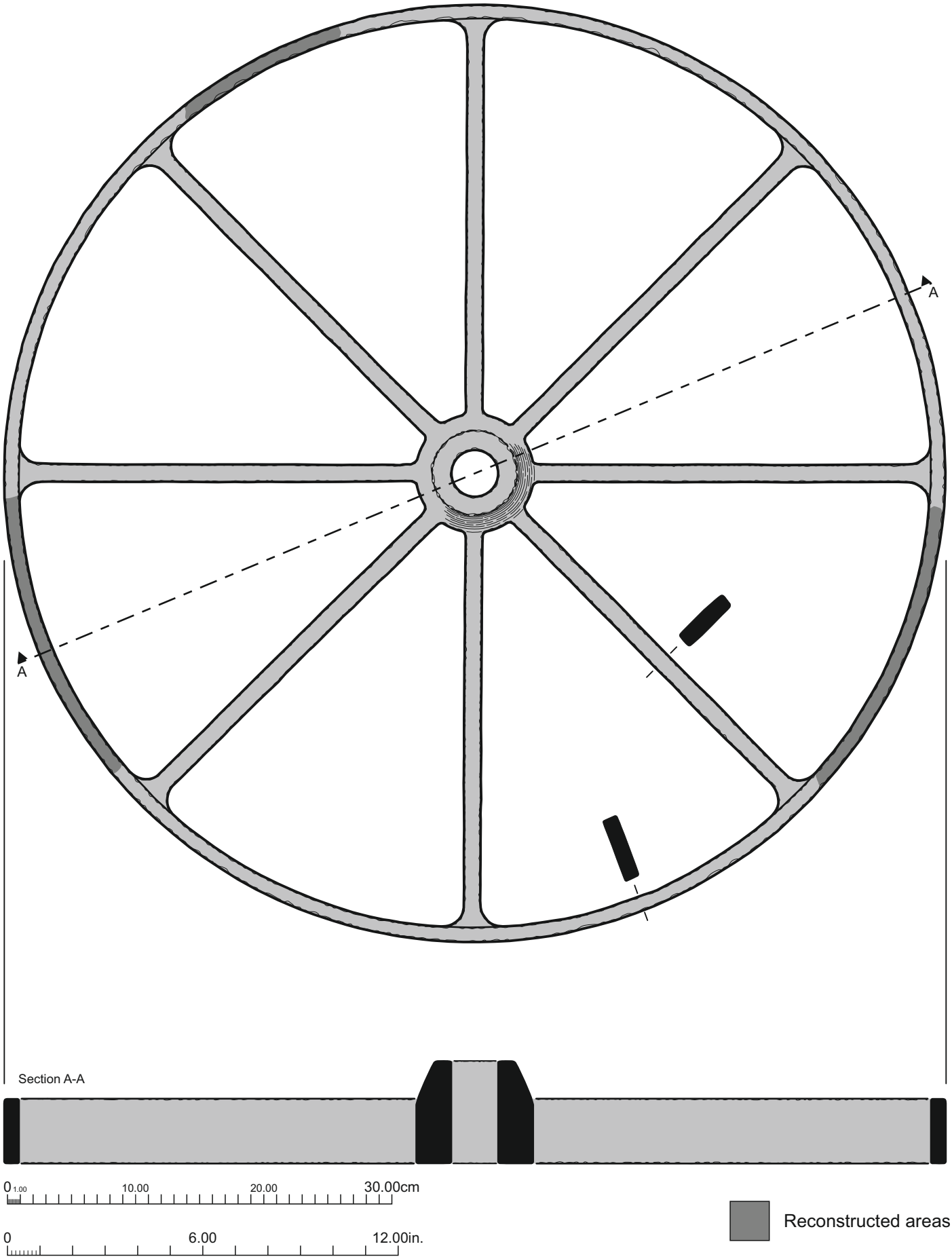

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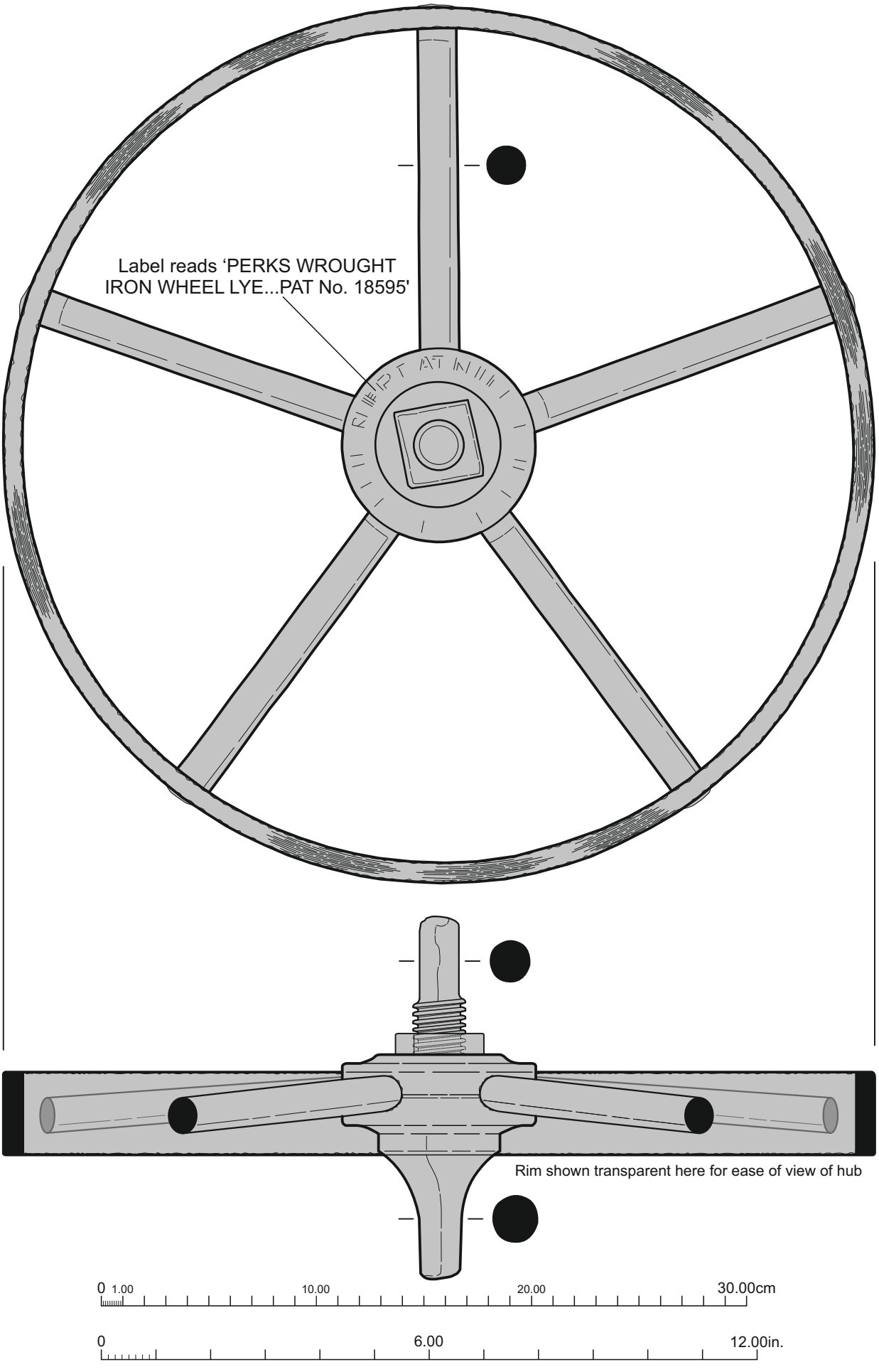

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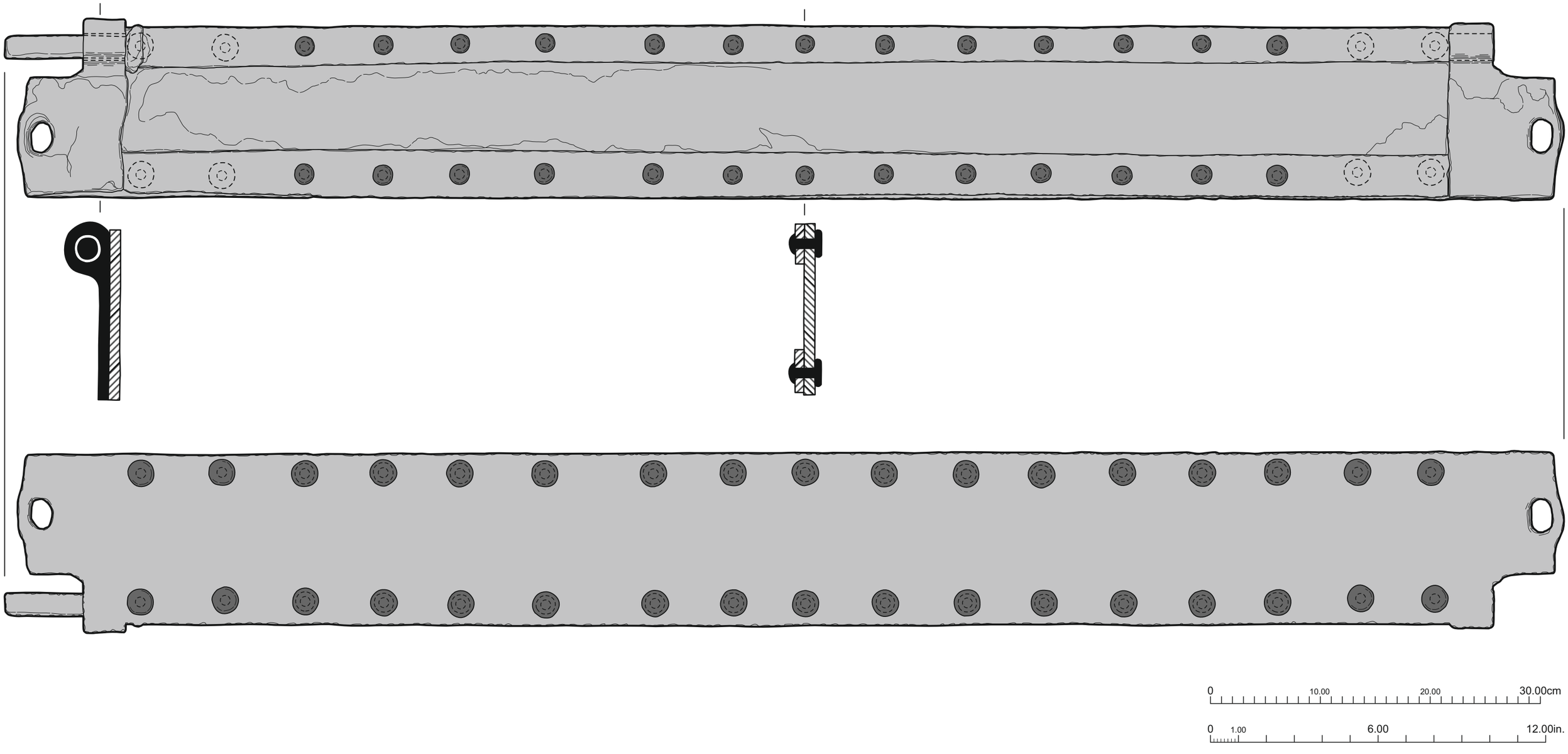

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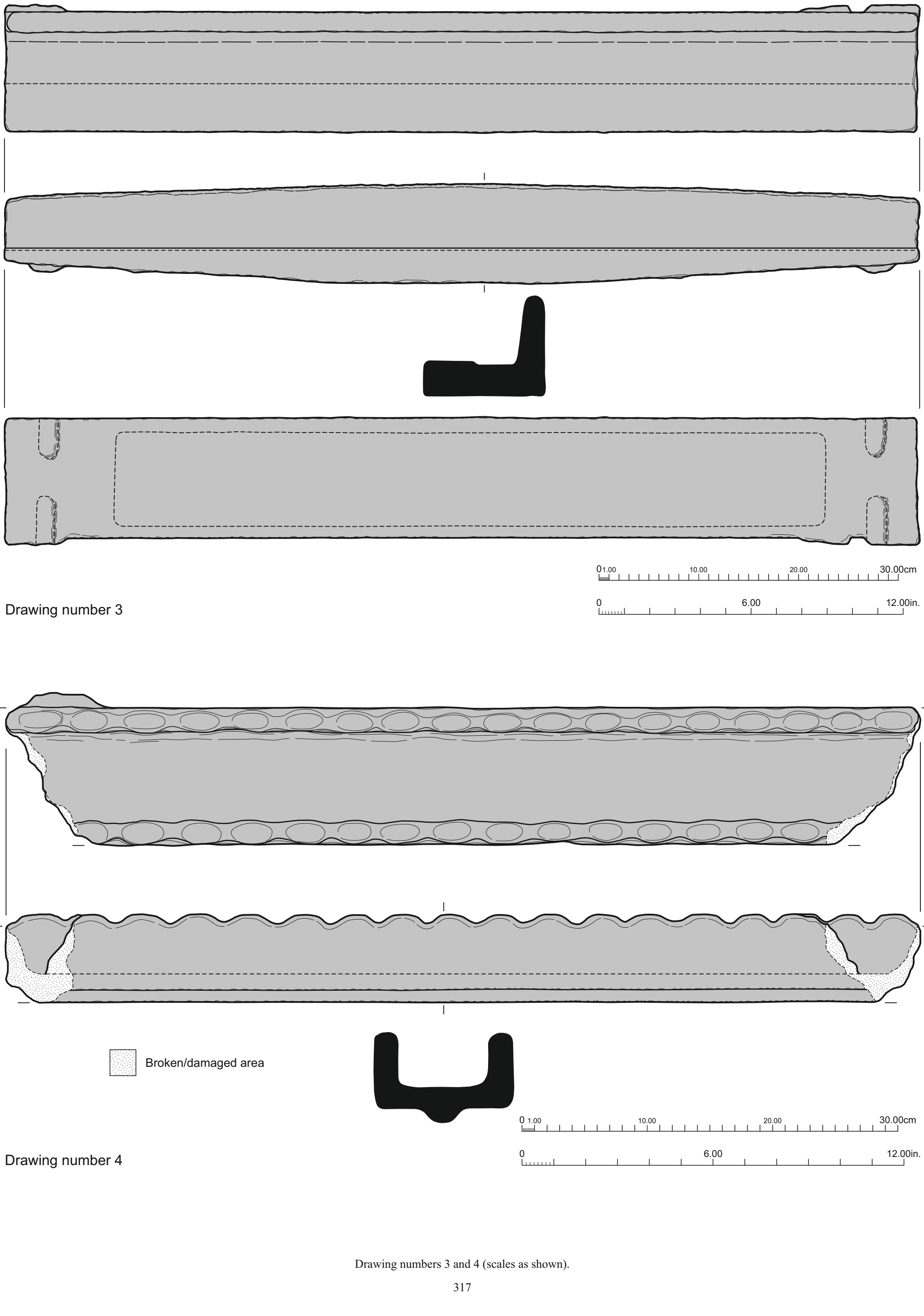
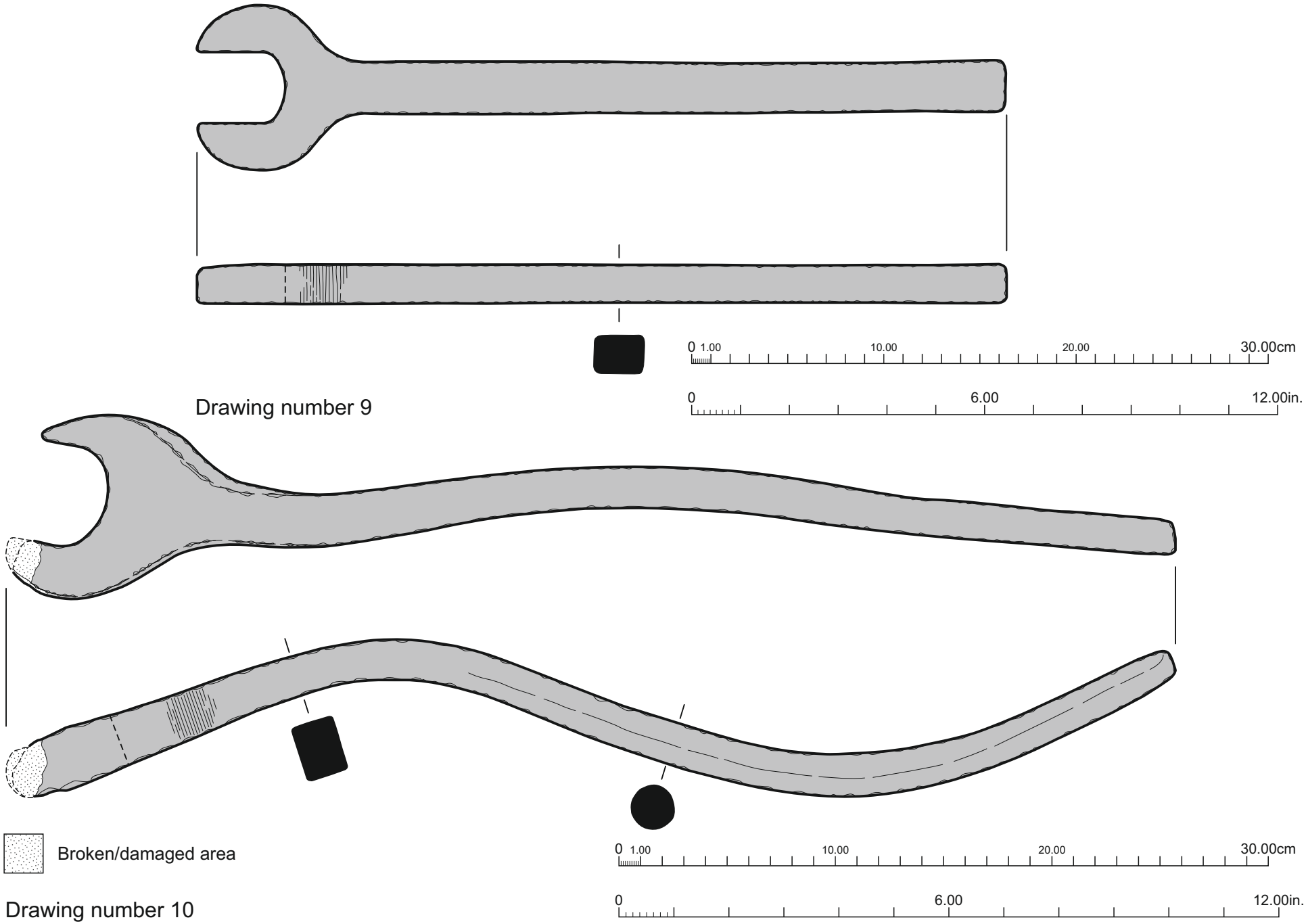


Drawing number 3

Drawing number 4

Drawing numbers 3 and 4 (scales as shown).



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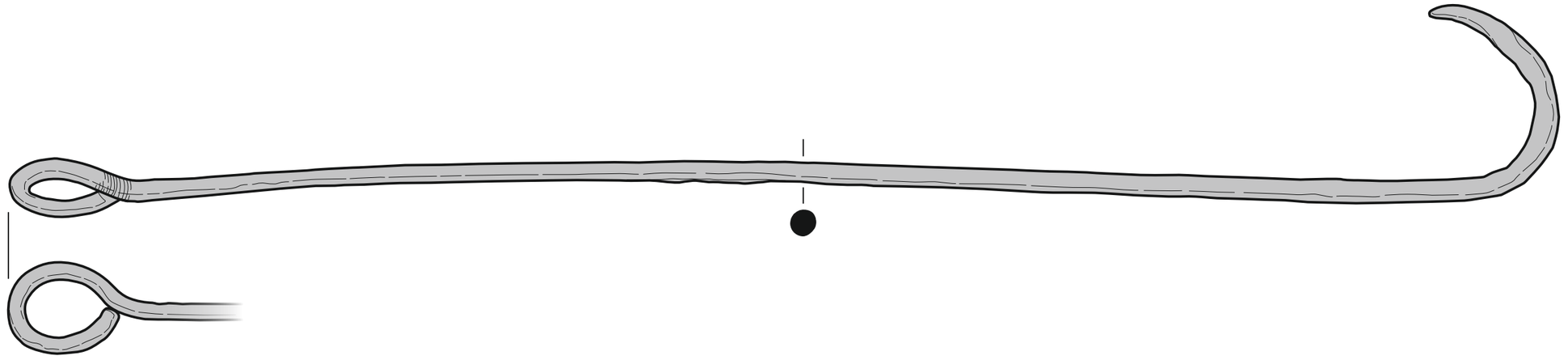

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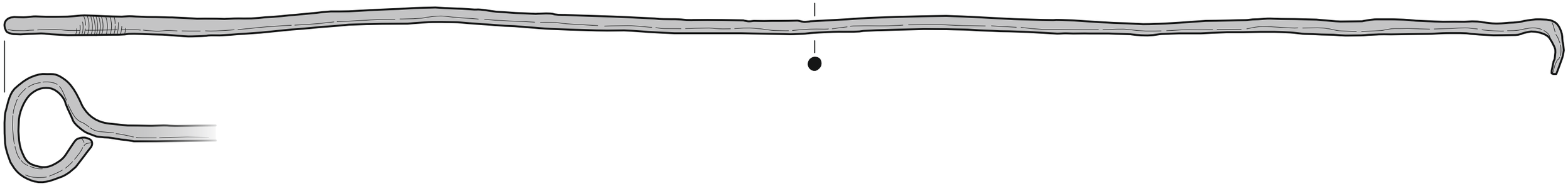

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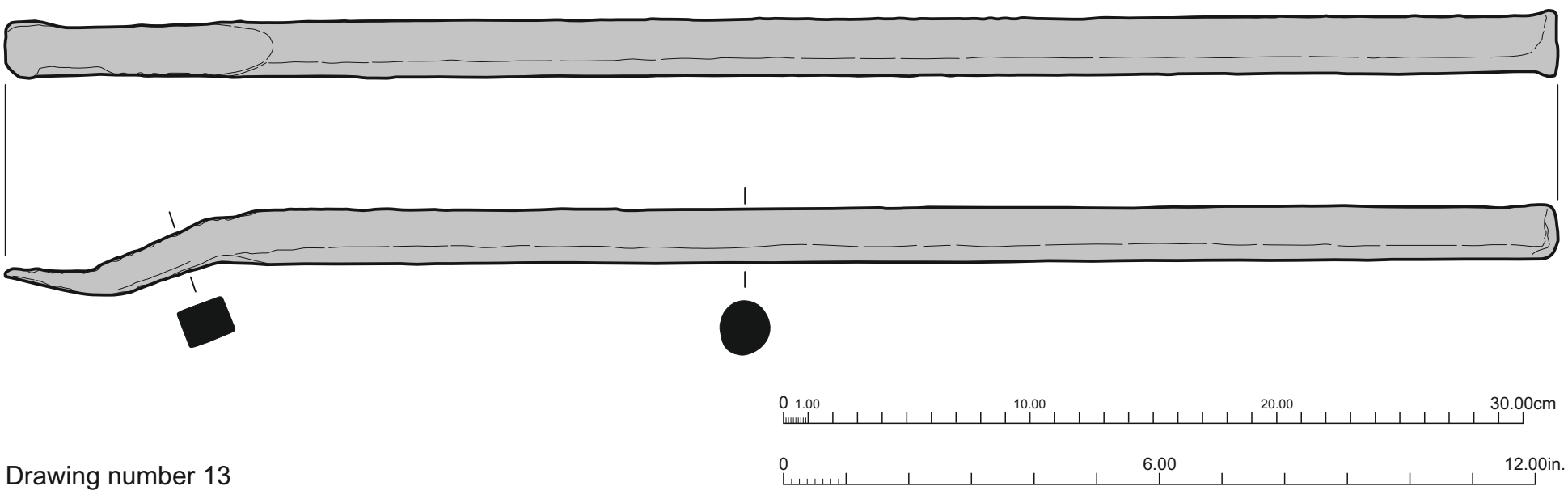

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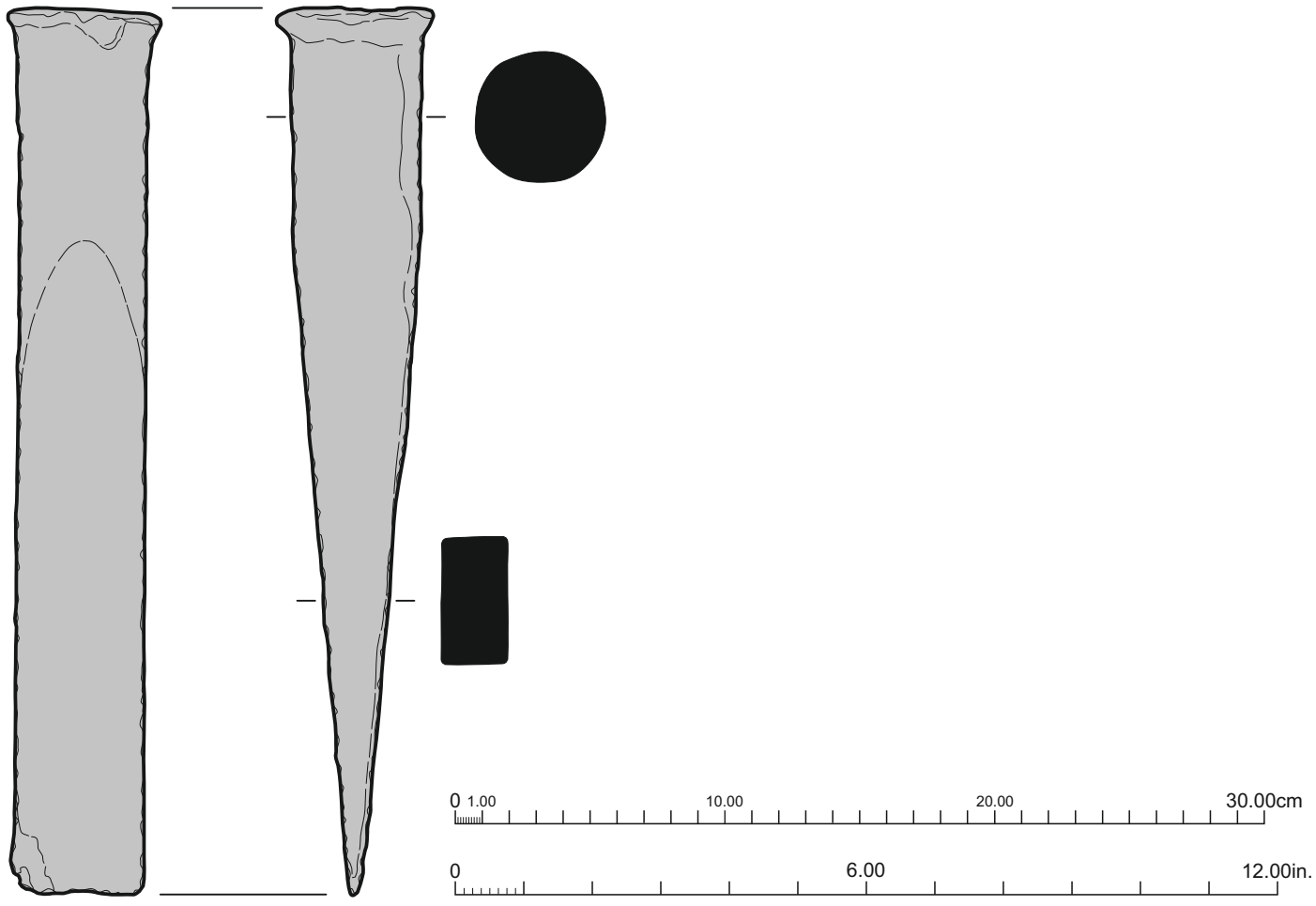
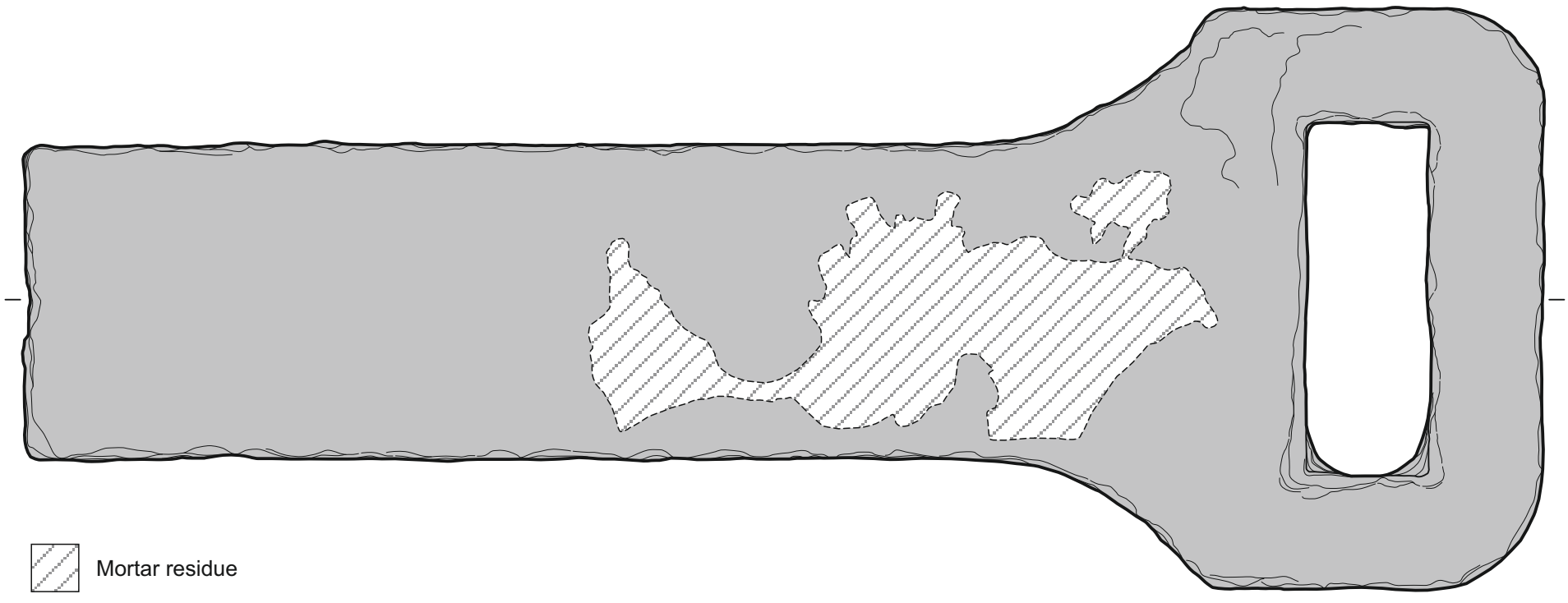


Drawing number 14

Drawing number 15

Drawing numbers 13, 14 and 15 (scales as shown).



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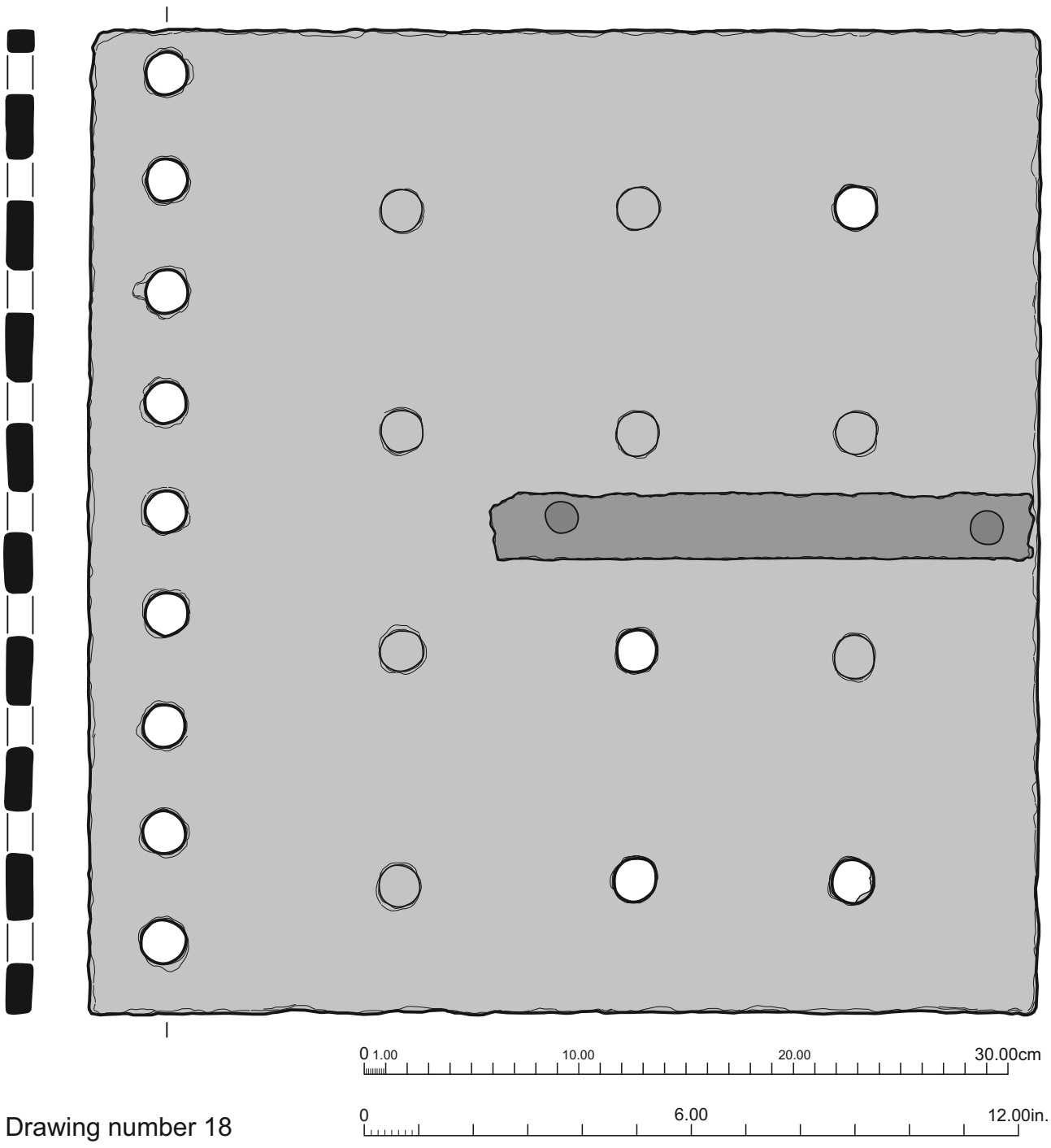
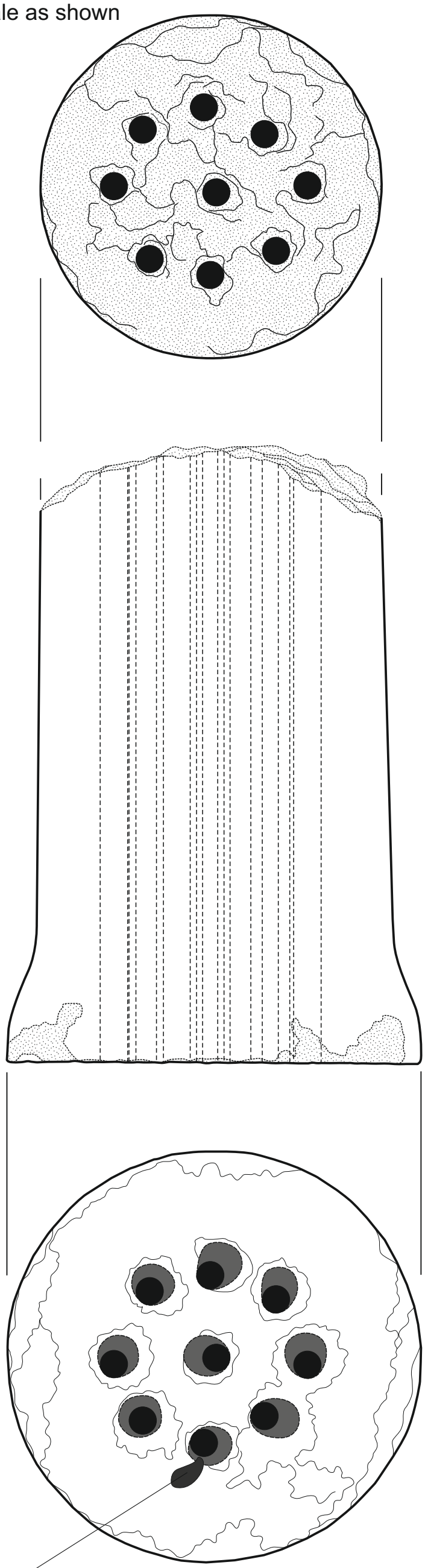


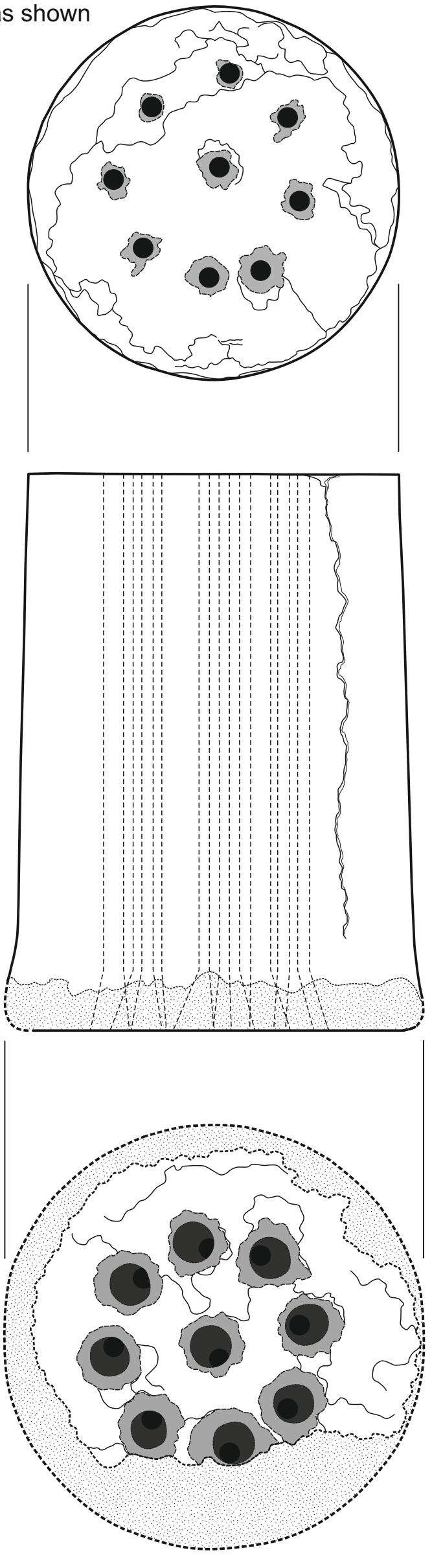
Drawing number 18

Drawing numbers 17 and 18 (scales as shown).

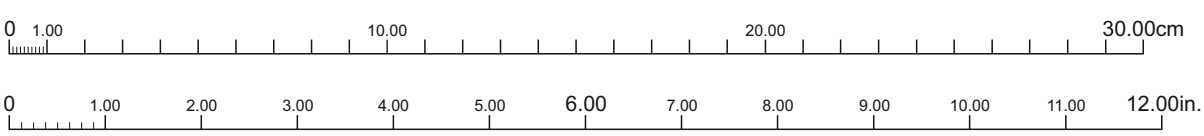
Cyfarthfa Coke Works 770
Drawing number 19
Truyére Type 1
Scale as shown



Cyfarthfa Coke Works 770
Drawing number 20
Truyére Type 2
Scale as shown



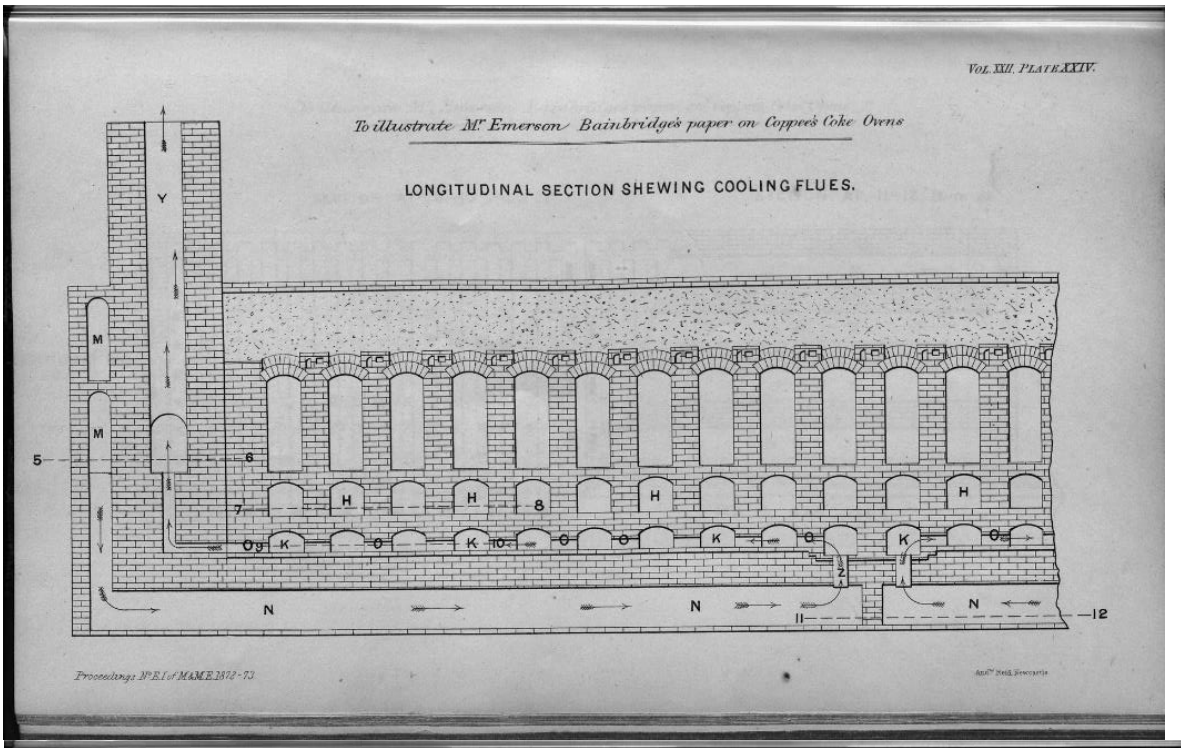
Broken/damaged area

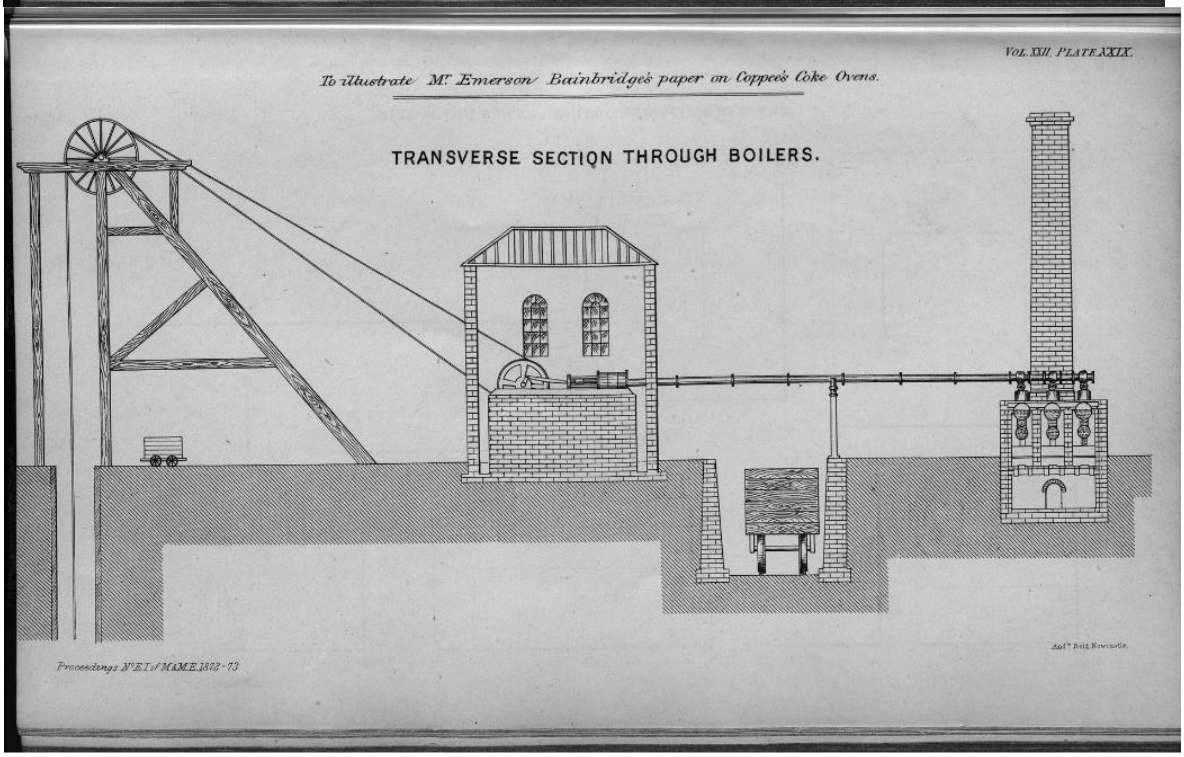


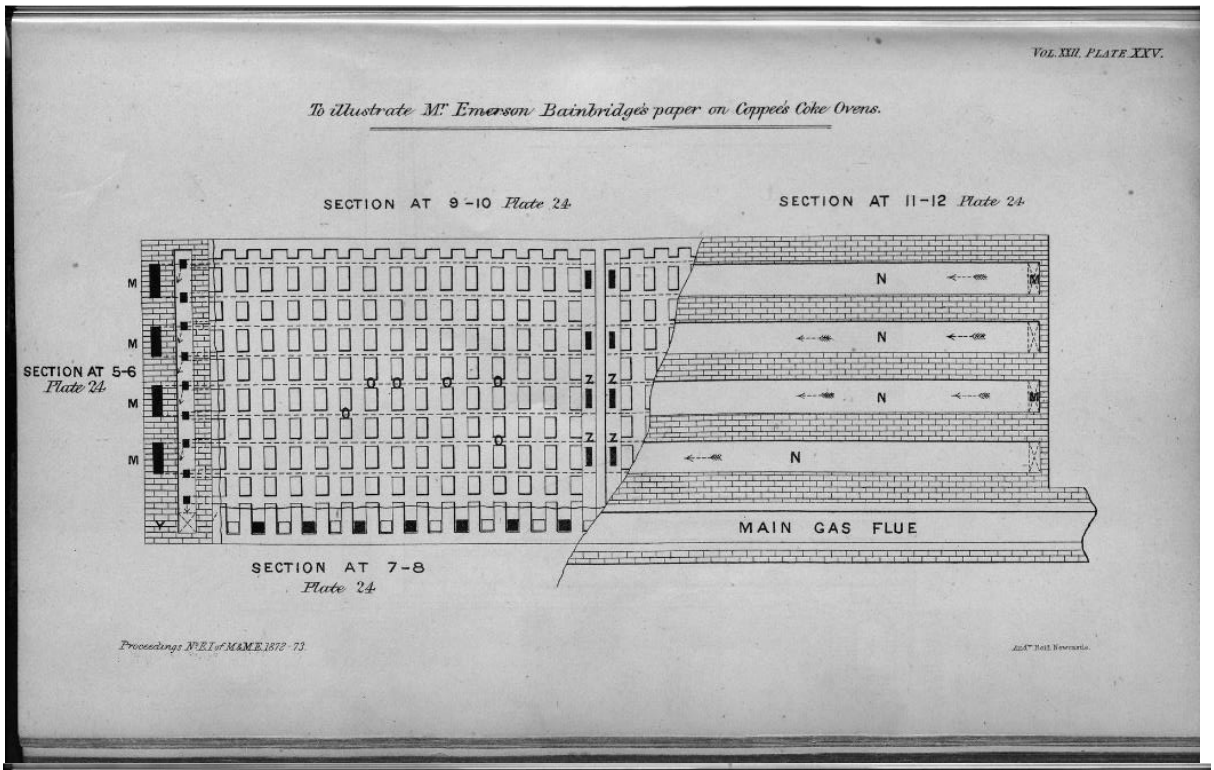
Drawing numbers 19 and 20 (scales as shown).

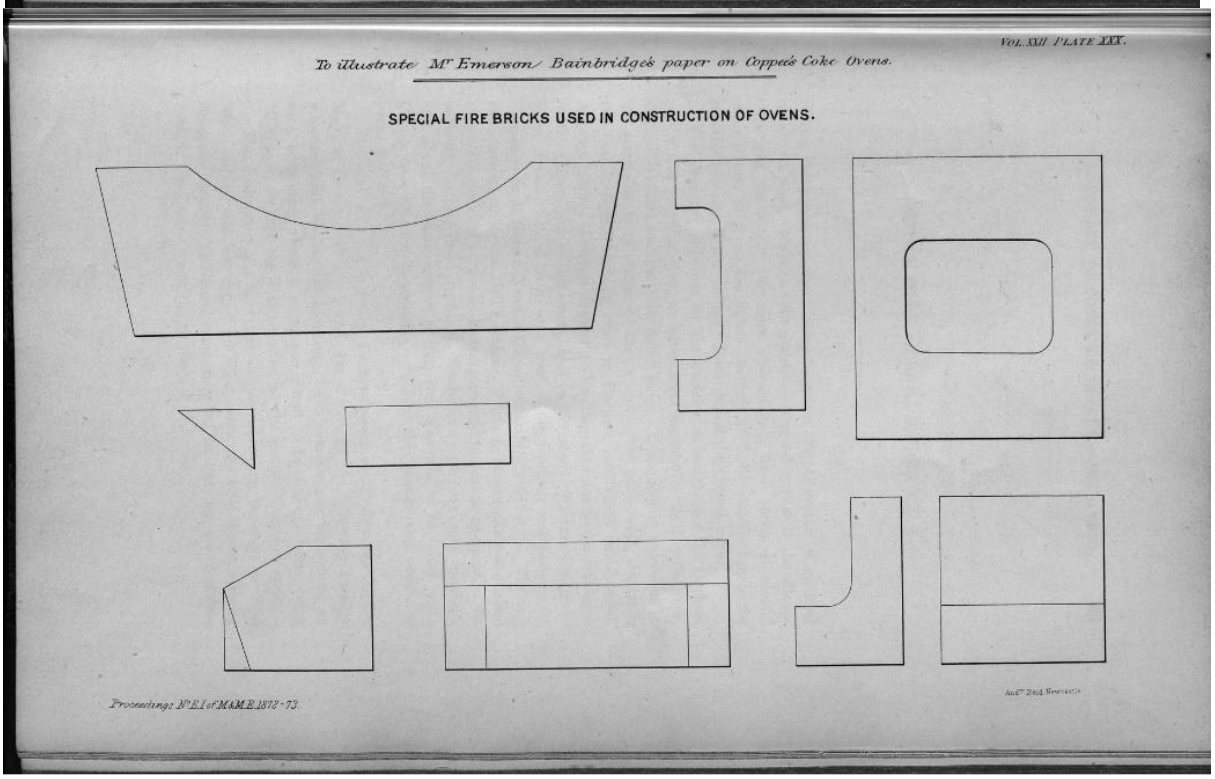
Appendix III Historical research documentation

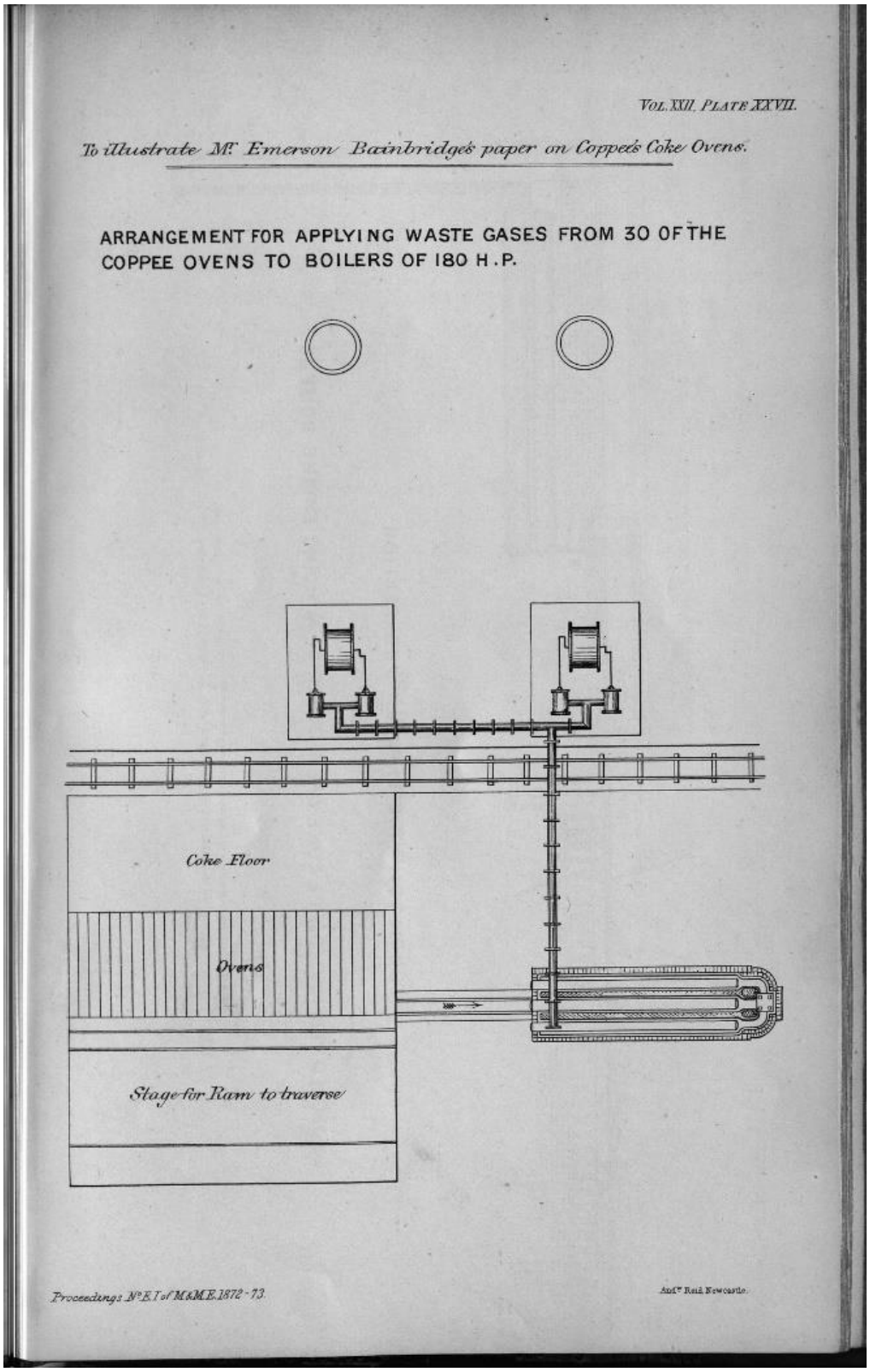
Illustrations of a Coppée coke oven from the Proceedings of the North of England Mining and Mechanical Engineers Institute Volume 22, 1872/1873. Reproduced with the kind permission of the NEMMEI.

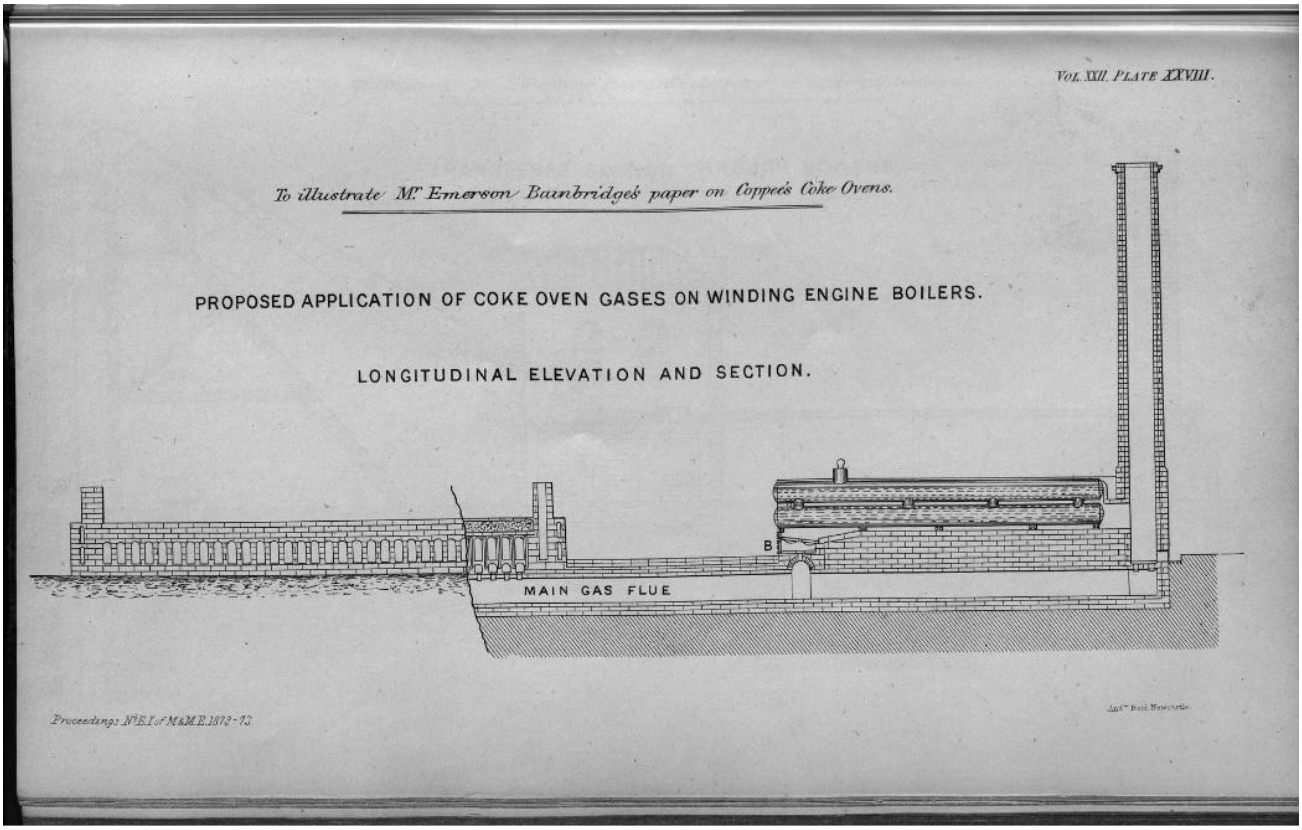




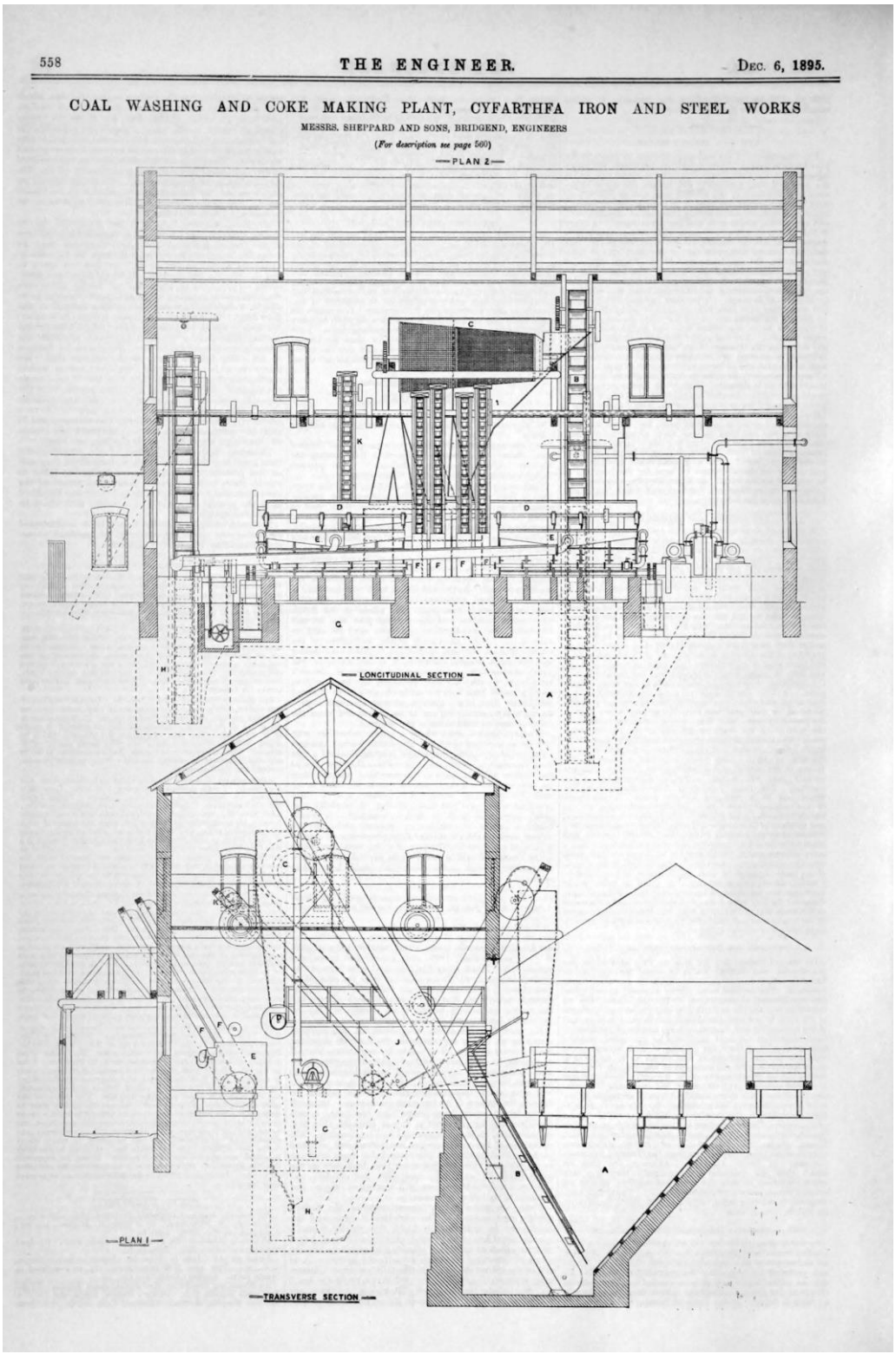

VOL. XXII. PLATE XXV.
To illustrate Mr. Emerson Bainbridge's paper on Coppee's Coke Ovens.
SECTION AT 9-10 Plate 24
SECTION AT 11-12 Plate 24
SECTION AT 5-6 Plate 24
SECTION AT 7-8 Plate 24
MAIN GAS FLUE
M
N
Z
Y
Proceedings N°E.I. of M&ME. 1872-73.


VOL. XXII PLATE XXV.
To illustrate Mr. Emerson Bainbridge's paper on Coppee's Coke Ovens.
SPECIAL FIRE BRICKS USED IN CONSTRUCTION OF OVENS.
Proceedings N°E.I. of M&ME. 1872-73.


VOL. XXII. PLATE XXVII.
To illustrate Mr. Emerson Bainbridge's paper on Coppee's Coke Ovens.
ARRANGEMENT FOR APPLYING WASTE GASES FROM 30 OF THE COPPEE OVENS TO BOILERS OF 180 H.P.
Coke Floor
Ovens
Stage for Ram to traverse
Proceedings N°E.I of M&M.E.1872-73.
And.r Reid Newcastle.


Vol. XII. Plate XXVIII.
To illustrate Mr. Emerson Bainbridge's paper on Coppee's Coke Ovens.
PROPOSED APPLICATION OF COKE OVEN GASES ON WINDING ENGINE BOILERS.
LONGITUDINAL ELEVATION AND SECTION.
B
MAIN GAS FLUE
Proceedings N.E.I. of M.&M.E. 1872-73

Extracts from The Engineer of December 6th 1895 detailing the Sheppard washer plant constructed at Cyfarthfa in 1894/5.



Cyfarthfa Coke Works, Merthyr Tydfil: excavation report and analysis

COAL-WASHING AND COKE-MAKING PLANT.

The accompanying engravings illustrate a coal-washing and sizing plant recently erected at the Cyfarthfa Ironworks in connection with the coking plant. Previous to the erection of the washing plant the coal was all passed through a large Carr's disintegrator, and large coal was frequently broken down by a set of large rolls, and also passed through the disintegrator, the object being to improve the coke by using a proportion of large or clean coal. In designing the coal-washing plant it was laid down that the existing crushing plant should remain intact, and that the washing machinery should be an addition to it, arranged so that in case of necessity the old system could be reverted to at a few minutes' notice.

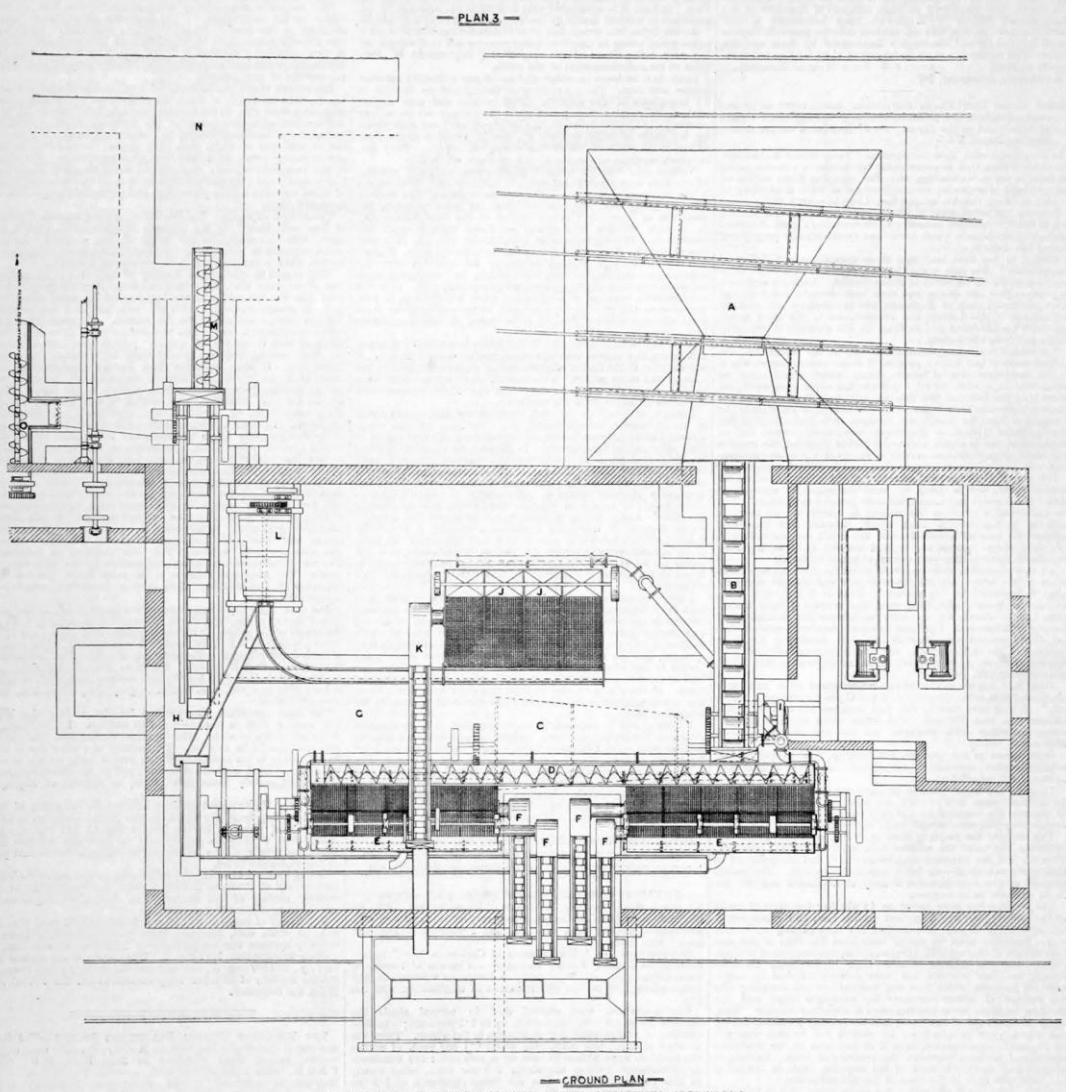
The contract for the coal-washing machinery was let to Messrs. Sheppard and Sons, Limited, of Bridgend, South Wales, in June, 1894, and provided for a plant capable of washing 500 tons in ten hours, the coal to be divided into three sizes. The machinery was completed and started in the early part of this year. The following is a brief description of the process with reference to letters on the drawings. The coal to be washed is procured from the several extensive collieries of Messrs. Crawshay Brothers, and consists of steam coal and bituminous coal. All of the coal has passed over the ordinary colliery screens with bars spaced at about 1¼in. The coal is brought to the washing machine in ordinary coal trucks on three lines of rails, and is unloaded by hand into a large hopper A. The proportion of steam coal to bituminous coal is regulated at this point, and varies from two-third steam coal and one-third bituminous coal to half and half. The two sorts of coal are mixed both by the unloading and by the subsequent elevating, screening, and washing. The coal is raised from the hopper by a large steel elevator B, made on the usual dredger pattern, viz., with one thick and two thin links alternately, with boxes 2ft. wide. This elevator, with drums making ten revolutions per minute, would deliver 55 tons of coal per hour. The coal is discharged by the elevator into a revolving screen C. This screen is about 16ft. long, tapered from 5ft. diameter at the small end to 8ft. at the large end, the first 9ft. is covered with strong steel wire cloth ⅜in. clear mesh and the remainder with ¾in. mesh. Upwards of 60 per cent. of the coal passes through the ⅜in. mesh, 20 per cent. through ¾in. mesh, the remaining 20 per cent. being larger. These three sizes may for convenience be termed nuts, peas, and duff.

Dealing with the duff coal first, it passes from the screen in a covered shute to a long distributing trough D, provided with a worm or screw, one half having right-hand screw and the other left-hand; the coal is divided at the point where the right-hand and left-hand screws meet, so that one half the coal shall travel in one direction, and the other half in the contrary direction. Under each half of the trough are arranged two sets of five-compartment Sheppard's automatic feldspar washers E, that is to say, in all, ten compartments. The coal is divided between these compartments by means of openings in the bottom of the trough, a jet of water playing upon each spout to prevent clogging. The feldspar washers are arranged in two sets of five compartments each; each compartment is divided into two parts, separated from each other by a vertical plate from top to bottom. In each half compartment is a steel box, with a perforated plate bottom, the perforation being larger than ⅜in., so that any particle of refuse can pass through it. The two boxes are hung one on each end of a beam, and act as pistons in the compartments, and balance one another. Motion is given to the beam by an excentric with variable stroke arrangement. In this case a stroke of ¾in. at 180 to 190 revolutions per minute was found to give the best results. The water for washing enters the washing compartments underneath the washing boxes and passes up through the feldspar and coal being washed. The coal is first washed in the back half compartments, and is carried by the water forward over the division plate into the front half, from which it passes with the water into the settling chamber.

The separation of the coal from the refuse is caused by the jigging motion imparted to the washing boxes by the excentric. On the perforated plate a layer of feldspar—or other material of about the same specific gravity—about 6in. deep is placed; the coal and refuse arrange themselves in layers on this according to specific gravity. The refuse, being small in size, works its way through the layer of feldspar, and passes through the perforated plate forming the bottom of the washing boxes, and falls into a chamber under it. At the bottom of these chambers runs a screw or worm, which collects all the refuse from each set of washing boxes and conveys it to one end, where the refuse elevators F F F F raise it by means of perforated boxes to a bunker.

The coal has now been carried by the water to the settling chamber G. The settling chamber may be said to be the heart of the whole plant, for upon its efficient working the success of the washing plant largely depends. It will be seen on reference to the plans that an elevator pit is formed at one end to receive the washed coal elevator H. The small coal and water are discharged into this pit, which is always kept full of water. The bulk of the coal is deposited at the foot of the elevator, while the water passes slowly to the back end of the settling chamber, a distance of about 45ft. Owing to the large sectional area of the settling chamber, the water travels very slowly, and has thus time to deposit the fine coal in suspension in it. A scraper is fitted into the settling chamber, which travels slowly, scraping all the deposited fine coal to the elevator pit, from which it is raised with the coarser coal by the elevator H. The use of this chamber enables the water to be circulated and used over and over again, without the use of settling ponds, with their attendant trouble and expense, the whole work in this instance being done mechanically. A centrifugal pump I, of large dimensions, circulates the water through the machinery.

To return to the screen, we have now to deal with the nuts and peas. Both nuts and peas pass down shutes into a four-compartment Sheppard nut washer J. The two sizes are washed in separate compartments, the pistons having a different stroke for each size. The coal in this case is washed on a fixed grating covered with perforated copper plates, through which the water is forced at each stroke of the pistons and the pistons making from 60 to 70 strokes of 5in.



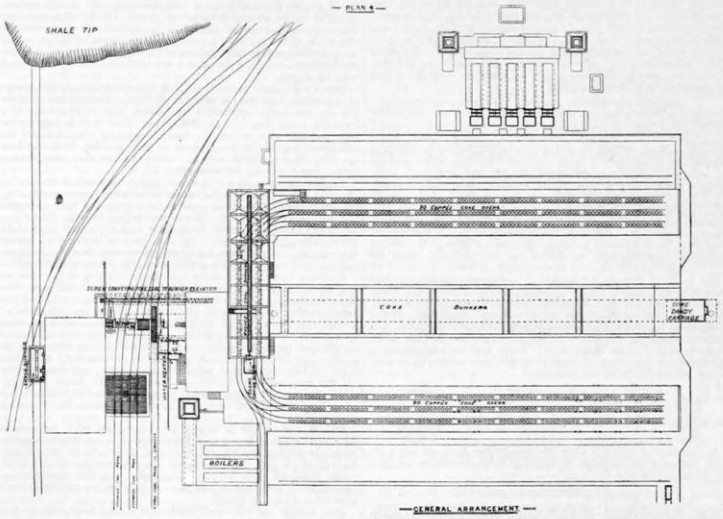
COAL WASHING AND COKE MAKING PLANT—CYFARTHFA IRONWORKS

Cyfarthfa Coke Works, Merthyr Tydfil: excavation report and analysis

to 7in. each per minute. The coal and refuse here arrange themselves according to specific gravity; the clean coal passing out over a dam with the water, the refuse accumulating on the front end of the copper plate, and being discharged by means of valves and hand wheels into the chambers beneath, from which it is collected and raised by elevator K, as in the feldspar machines. The nut and pea coal, on leaving the washing machine, passes to a revolving screen L—Plan 3—made of perforated plate. The perforation in this screen is merely to allow the water to escape and return to the settling chamber.

The coal, after leaving the screen, falls into a screw and trough M, which conveys it to the foot of the elevator N—Plan 4—which raises it to the disintegrator. After passing through the disintegrator the coal falls to the foot of a second elevator, where it meets the fine coal which has been conveyed from the washing machine by the screw O, under the rails. Thus all the coal is reduced to the necessary fineness, and raised together to the extensive storage bunkers shown on Plan 4. These bunkers are capable of holding from 500 to 600 tons of clean coal, and are fitted with distributing screws, so that the coal may be taken to whichever part requires filling.

The arrangements at the coke ovens are very complete. The ovens are of the Coppée type in two banks of 90 each. Bunkers to receive the coke are formed between the two banks, and a very ingenious arrangement for conveying the coke to the blast furnaces has been adopted. The coke dandies are placed on a low truck worked by wire ropes and



COAL WASHING AND COKE MAKING PLANT, CYFARTHFA

a small engine, and drawn under the bunkers to be filled by sliding doors under the coke bunkers. Several can be taken at each journey. After they are filled the truck is withdrawn, and the dandies are brought back to a point level with the top of the furnaces, to which they are wheeled direct—see Plan No. 4.

The following figures serve to show the excellent results obtained by the use of this plant, taking the week just ended, September 20th:—

Coal delivered to washing machine for week, 2674 tons 11 cwt.; refuse extracted by feldspar washing, 125 tons 13 cwt.; refuse extracted by nut and pea coal washing, 133 tons 3 cwt. Total, 258 tons 16 cwt. Average coal washed per day, 445 tons 15 cwt.; per cent. of refuse removed by washing, 9·6. Loss of coal due to washing, ·25 per cent. on quantity washed; in other words, 5 cwt. per 100 tons. Analysis of coal and coke:—Coal before washing, 12 per cent. of ash; volatile matter, 18 per cent.; coal after washing, 5·5 per cent. of ash; coke resulting, 7·4 per cent.

These results, we are informed, are a sample of an ordinary week's work. The very small amount of waste due to washing is very remarkable, the more so as it represents the whole loss. There are no settling ponds to be cleaned out, as in most other systems, and this is an advantage greater than may appear at first sight, as the fine coal collected in the ponds usually contains a much heavier per cent. of ash than the washed coal. It is of very little value for coking, as it cannot be effectually mixed with the larger portion of clean coal unless passed through a disintegrator with it. The whole of the coal is by this machinery delivered together, and that without any additional cost or handling. It should be further stated that the steam for the washing and crushing plants, as well as for a large part of the works, is provided by the waste heat from the Coppée ovens supplied to ten large Lancashire boilers. Both iron and steel works are fitted with all the most recent improvements for cheap production and large output, and, under the able management of Mr. William Evans, are amongst the most successful undertakings of the kind in the kingdom.

MAGNETIC TESTER FOR SHEET IRON.

THE award of a Royal medal by the Royal Society to Professor Ewing for his work on magnetisation effects recalls the paper which he read to the members of the Institution of Electrical Engineers at a meeting in the last session, entitled "A Magnetic Tester for Measuring Hysteresis in Sheet Iron." The author having stated that transformer makers find the great importance, from the point of view of all-day efficiency, of using sheet iron in which the hysteresis losses are small, referred to the wide differences exhibited in this respect by different samples of iron as shown by the ballistic and other methods of testing. What was wanted, he considered, was a sufficiently large number of tests in any one batch of iron to allow of a fair average to be estimated for the quality of the batch. The ballistic method, although unimpeachable on the point of accuracy, was anything but expeditious, and could scarcely be called simple. The apparatus devised by the author measures the hysteresis directly by a single operation, and in a manner sufficiently simple to permit of the test being applied to many specimens without taking up much time, trouble, or iron. The instrument is based upon the mechanical measurement of the work done in causing reversals of magnetism to take place in the iron under examination. The instrument is brought forward as a practical tester for workshop use. The process of reversal resembles that which occurs in a transformer rather than in a dynamo, and the induction is caused to have practically the same value in all samples. The samples to be tested are cut in a simple form, and are arranged to be readily inserted and removed. The reversal of the magnetism is effected by turning a handle, and the result is indicated by the position of a pointer on a scale. The iron samples are cut or stamped in the form of strips 3in. long, $\frac{3}{4}$in. wide. The sample is composed of six or seven of these strips for the usual gauges of transformer iron, whilst a smaller number is used if the material tested is the thicker sheet used in dynamo armatures.

The magnetic tester consists of a permanent magnet arranged vertically and swinging about a knife-edge working in an agate trough, a lifting arrangement being provided like that of a balance, so as to save the knife-edge from unnecessary wear and tear. The pointer, which is carried by the upper part of the magnet, is set to zero in the middle of the scale by means of a nut which runs on a screw projecting sideways from the middle of the magnet, and a more delicate adjustment of the zero may be effected by means of a levelling screw. The bundle of iron strips constituting the sample to be tested is placed in a carrier, and is covered with a vulcanite washer and secured by two clamps. The carrier is made to rotate by means of a friction pulley and hand driving wheel. This causes the sample to revolve between the poles of the magnet, with the effect that its magnetism is periodically reversed. The work done in reversing the magnetism in consequence of hysteresis causes a mechanical moment to be exerted by the revolving sample upon the magnet, and the latter, owing to its support by the knife-edge, previously mentioned, and which is in line with the axis of the carrier, tends to follow the sample, and is deflected through an angle which serves to measure the work expended. Since a definite amount of work is done per reversal, the deflection of the field magnet is independent of the speed at which the carrier revolves, and no special care has to be taken to turn the handle of the driving wheel at a uniform rate. The swinging of the magnet is checked by a dash-pot below, and the stability is adjusted to give any required degree of sensitiveness. The operation of testing is effected by the insertion of the sample, and after reading the deflection of the pointer to one side, the observer reverses the direction of rotation, reads the deflection to the other side, and takes the sum of the two readings as the total deflection. The deflection is proportional, or approximately so, to the hysteresis of the iron, even when a comparison is made of samples widely different in quality. To insure that this shall be so, a considerable air space is left between the magnet poles and the ends of the sample, with the result that such variations of permeability as are liable to be met with in different samples of iron are almost without influence upon the total induction through the iron. The dimensions and strength of the field magnet are so proportioned with reference to the section of the sample, and to the extent of the air gaps, as to cause the induction to have a value fairly representative of transformer work. In the tester exhibited in operation to the meeting, the induction is about 4000 C.G.S. units, with the normal size of test sample. By increasing or reducing the area of section of the sample, the intensity of the induction is reduced or increased. Within reasonable limits, however, any value of this intensity may be adopted in testing.

If a weight of a sample chosen is equal to that of seven pieces of this material as a general standard, it will suffice in preparing other samples for testing, to select that number of strips which will give a weight approximating even roughly to the standard weight. The nearest whole number of strips will do, and it is not necessary to cut a narrow or wide strip to make up the exact weight. Discussing the question of calibration, an exhaustive series of experiments has been made to determine to what degree of accuracy the readings of the magnetic tester correspond to the hysteresis losses as found by ballistic tests for various samples of iron. A comparison showed that both accord well to one another, and that the scale reading of the magnetic tester is nearly proportional to the hysteresis loss. The hysteresis of the standard samples is stated for B = 4000. To find the hysteresis for any other induction, it is only necessary to use a table of factors given in the paper, and deduced by the author as a general mean from ballistic tests of many samples. In conclusion the author said that the instrument could be constructed in various ways, and that his object had been to facilitate testing by makers of plates and transformers, and by engineers of alternating current supply stations.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Pipe and coke works.—The Howard and Harrison cast iron pipe works at Bessemer are among the largest in the world, and make very large sizes of pipe as well as the ordinary commercial sizes. The pipes are cast vertically, the moulds standing in large circular pits, which are served by ladles handled by jib cranes operated by steam. These steam cranes, however, are being replaced by electric cranes, or rather the steam operating machinery is being replaced by electric motors. There is thus less gearing and machinery to each crane, while there is a great saving in steam, the small engines on the cranes being necessarily very wasteful. An important improvement is the drying of the cores by hot air, which is blown by a Root blower through a cast iron hot-blast stove similar to the old style of stoves used at blast furnaces before fire-brick stoves came into general use. The hot-blast stove is heated by the waste heat from the coke ovens, and it is intended also to use the hot-blast for blowing the cupolas, by which a considerable saving of coke will probably be effected. At the coke works connected with the pipe works, the coal is first washed in order to reduce the ash and remove the sulphur. The washed coal is coked in a hundred ovens, arranged in two rows, and underground brick flues laid behind the ovens carry the waste gases to the boilers which supply steam for the pipe and coke works, and to the hot-blast stove above mentioned. Enough air enters the flues through the small openings in the tops of the ovens to cause the combustion of the gases in the flues, so that no air for combustion is admitted at the boiler furnaces or stove. It is probable that ovens for saving the by-products will be introduced at these and other coke works.

Irrigation work.—Besides the large irrigation works in the arid regions of the West constructed by private companies for their own lands or to supply farmers, a number of smaller individual plants for irrigating farms, orchards, gardens, &c., have been established with eminently successful results. On large works the cost of canals and ditches has been greatly reduced by the introduction of grading machines. The average cost per mile of constructing irrigation canals in various States is as follows, in English money:—

	Under 5ft. wide.	5ft. to 10ft. wide.	Over 10ft. wide.
	£	£	£
Arizona	94	335	1055
California	177	1192	3102
Colorado	76	226	1052
Idaho	41	162	264
Montana	65	160	460
Nevada	40	230	—
New Mexico	62	116	1333
Oregon	52	212	260
Utah	98	205	614
Washington	57	247	514
Wyoming	—	167	777
Sub-humid Region	61	89	377
Average	96	325	1120

On large works the quality of water available, quality of soil, engineering works, and the quantity and distribution of water have all to be carefully considered, and then when the farmer gets the water he must know how to use it for each individual crop which he grows—different kinds of grain, vegetables and fruit requiring entirely different treatment. In some cases irrigation from below is used, by means of pipes buried in the ground and closed at the lower end. It is also sometimes desirable to apply irrigation water, but to carry the water off quickly, so as not to soak around the roots and keep the earth damp. To effect this, the drains of ordinary or porous clay pipe may be laid, or trenches may be dug, filled with broken stone and gravel, and then covered over with the earth in which the crop is grown.

Windmill pumps for irrigation work.—Great improvements have recently been made in windmills for driving pumps, and wind pumps are largely used for filling farm and private tanks, railway tanks, and for supplying irrigation ditches. According to a recent work on irrigation farming a 16ft. wheel at a 100ft. well can furnish a supply for 5 acres to 10 acres, discharging the water into a reservoir or head pond. The wheels are of steel or wooden slats, or sometimes steel "spoons," the latter being said to give greater power than those with slats. A vane or tail holds the wheel in the wind, and the wheel may be put out of service by folding the slats, this being done by a lever operated from the ground. The wheel is usually geared to make three revolutions to one stroke of the pump, which gives economical work, as a high-speed wheel is better than a slow-speed wheel. Iron towers are commonly used, built of piping or of structural iron, according to the size. The tower should always be so high that the bottom of the wheel will be at least 10ft. above the roofs of building, trees, or other near-by obstructions, as such obstructions interfere with the direct current of wind on the wheel, and also cause cross-currents. The higher currents of air are also more uniform and steady than those at a lower level. The work done depends upon the prevailing winds, but on an average there will be eight to ten hours a day with a wind of eight to fifteen miles per hour, giving a pressure of $\frac{1}{2}$ lb. to 1 lb. per square foot, while in some cases it will be fifteen to twenty-five miles per hour, or 1 lb. to 3 lb. per square foot. To irrigate an acre with 1in. depth of water will take 27,154 gallons, and 1-horse power, with good machinery, will raise this 1ft. high in ten minutes.

Painting locomotive boilers.—At a recent meeting of the New York Railroad Club, a paper on "Painted or Planished Iron for Locomotive Boiler Jackets" was read by Mr. E. E. Russell Tratman. The use of planished iron for locomotive boiler jackets has been almost universal in the United States until within the past few years, but many roads are now making experimental trials of common iron or steel painted. It has very frequently been assumed that painted jackets would be the more economical, and European practice in this respect is commonly cited as an example of this class of work, but while they may be made more economical than planished iron jackets, yet, on the other hand, the work of painting may be so elaborate as to make the finished jacket more expensive. European practice—and especially English practice—was by no means recommended, as the variety of colours used, the amount of striping and decoration, and the elaborate finish preclude any idea of economy. A planished iron jacket is necessarily expensive in first cost; it requires considerable care and cleaning; the thin metal soon gets dented and battered; the dripping from the round-house roof will eat away the enamel; and when the surface begins to wear in bright spots and to rust, the entire jacket soon looks shabby and must be renewed. A much cheaper quality of iron is used for a painted acket, and if economy is the first consideration, the painting may be cheaply done, and yet be of fairly good appearance, durable, and costing little for maintenance. Since the common iron or steel is as efficient as the more expensive planished iron, as far as clothing purposes are concerned, it would seem to be true

Appendix IV Open Day

On 7th September 2013, an open day for the general public was held, sponsored by Hammerson plc. This provided an opportunity for the local community and others to view the archaeological remains at their fullest extent, and to learn more about the coke works and its history.

The event was an outstanding success, with an estimated attendance of 1500 people who visited the site (Plate 145). Members of the public were guided by an archaeologist and had opportunities to ask questions as the tour progressed. As there had been an expectation of only several hundred visitors, the large gathering demonstrated the degree to which local communities are willing to engage with their past. It must be stated though that the demolition of some of the upstanding remains, as per the agreed recording and construction programme, several days after the open day had a pronounced negative effect on public opinion. In the future, public expectation concerning the recording and preservation of archaeological remains, needs to be managed realistically to reduce any negative reactions.

Plate 145. Some of the 1500 visitors to the Cyfarthfa Coke works Open Day being briefed by Martin Tuck, the Excavation Director.

Glamorgan-Gwent Archaeological Trust Ltd

QUALITY CONTROL

Report Title:: Cyfarthfa Coke Works, Merthyr Tydfil: excavation report and analysis

Report Date: November 2017

Report Number: 2017/051

Report prepared by: Johnny Crawford

Position: Assistant Project Manager

Date: 27/11/2017

Illustrations prepared by: Paul Jones

Position: Senior Illustrator

Date: 23/10/2017

Illustrations checked and authorised by: Paul Jones

Position: Senior Illustrator

Date: 27/11/2017

Report checked and authorised by: Martin Tuck

Position: Senior Projects Manager

Date: 27/11/2017

As part of our desire to provide a quality service we would welcome any comments you may wish to make on the content or presentation of this report.

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