The former Monk Bridge Iron Works, Leeds, West Yorkshire

National Grid Reference: SE 2903 3307

Archaeological Assessment Report

Report 971b.2(4) © ARCUS 2008

Fieldwork

Neil Dransfield, Tim Cobbold, Ashly Tuck, Roz Sampson, Paul Beers, Owen Raynold, Richard Jackson, John Howorth, Lauren McKintyre and Elliott Barry.

Reporting

Neil Dransfield

Illustrations

Chris Breeden

Archive

Linzi Harvey

Checked by:	Passed for submission to client:
Date:	Date:
Project Archaeologist	Assistant Director

OASIS SUMMARY FORM

PROJECT DETAILS		
OASIS identifier	Arcus2 - 52817	
Project title	The former Monk Bridge Iron Works	
Short description of the project	Evaluation and mitigation excavations and program of strip and record of the Tyre Mill building, Rolling Mill and Puddling Sheds, within a former iron works. The iron works, originated by Stephen Witham in 1851 and taken over by Sir James Kitson in 1854, was at the forefront of technological innovation in iron production during the middle of the 19th-century. The Tyre Mill was set up to produce weld-less iron tyres for steam locomotives and may have exported to the USA. The puddling sheds underwent several re-developments which may have included very early (1850/60's) experimentation in steel production or puddling using gas regenerative furnaces, originally patented by Frederick Siemens in 1856.	
Project dates	September 2006 – January 2007	
Previous/future work	Previous works include two desk-based assessments:- Fitzgerald, R., 2004, *Archaeological Desktop Assessment of the Monk bridge Ironworks*, Whitehall Road, Leeds. Structural Perspectives Ltd., Unpublished Report; Kinchin-Smith, R. 2004. *Monk Bridge Forge: Historic Building Assessment*. RPS unpublished report; a standing buildings assessment; Jessop, O. and Douglas, M. (forthcoming). *Archaeological Building Recording of Monk Bridge Forge, Whitehall Road, Holbeck, Leeds, West Yorkshire.* ARCUS Unpublished Report 971.1 (2) and an interim archaeological assessment; Dransfield, N., McCoy, M., and Davies, G., 2006 *Interim Assessment of Archaeological Evaluations at Monk Bridge Forge, Whitehall Road, Leeds, South Yorkshire*. ARCUS Unpublished Report 971b.1(1). Future works may include a full client copy excavation report as a primary site archive, a monograph in the 'ARCUS Studies in Historical Archaeology' monograph series and an article regarding the gas regenerative furnaces and metallurgical analysis in an appropriate paper such as the 'Journal of Historical Metallurgy'.	
Monument type and period	Iron Works – mid-late 19th-century	
Significant finds (artefact type and period)	Early (mid-19th-century) gas regenerative furnaces, puddling furnaces with in-situ slag deposits and a 'tyre blocking press' involved in the production of weld-less iron tyres for steam locomotives	
PROJECT LOCATION		
County/Parish	West Yorkshire, Leeds	
Site address	Whitehall Road, Leeds, West Yorkshire	
Site co-ordinates	NGR SE 2903 3307	
Site area	3335m²	
Height OD	Max: 30.245m / Min: 27.115m	
PROJECT CREATORS		
Organisation	ARCUS	
Project brief originator	WYAAS	
Project design originator	WYAAS	
Project supervisor	Neil Dransfield	
Project managers	Glyn Davies, Anna Badcock	
Sponsor or funding body	BAM (formerly HBG Properties)	
PROJECT ARCHIVES		
Archive Type	**Location/Accession no.**	**Content (e.g. pottery, metalwork, etc)**
Physical	Leeds Museum	Animal bone, ceramics, clay pipe, glass, tap slag, bar iron, flue slag, vitrified brick, leather
Paper	Leeds Museum	Field archive , colour slides, black and white negatives, interim assessment report, assessment report
Digital	Leeds Museum	PDF copies of reports, digital photographs, database archive listings
BIBLIOGRAPHY		
Title	Archaeological Assessment Report for the former Monk Bridge Iron Works	

Report no	971b.2(4)
Author	Neil Dransfield
Date	November 2008

CONTENTS

LIST OF ILLUSTRATIONS AND PLATES

Illustrations

Plates

NON-TECHNICAL SUMMARY

ARCUS were commissioned by RPS Planning & Environment, on behalf of their client BAM (formerly HBG), to undertake a programme of archaeological evaluations and mitigation at the site of the former Doncaster's, Monk Bridge Iron Works, Whitehall Road, Holbeck, Leeds, West Yorkshire, centred on SE 2903 3307.

Five areas were initially targeted and stripped by machine to the archaeological levels. This was to allow an evaluation to take place and to define areas for detailed mitigation excavation.

Three of the initial trenches were then fully excavated and a further three large areas linking the trenches within the building footprints of the historical iron works were then subject to a detailed strip and record. An initial attempt to record more information in a watching brief of the ground reduction was halted due to limited archaeological returns and health and safety considerations.

The excavations revealed good preservation across the site allowing excellent insights into the chronological development of the iron works and associated buildings and the organization of space within the individual buildings. The excavations also allowed excellent opportunities to examine structures such as the gas regenerative furnaces and the puddling furnace bases as well as examining the wider workings of each building during particular phases.

This report recommends that a further detailed client report should be undertaken both to refine the chronological development of site and to clarify the industrial processes and use of space within the buildings. This will involve close correlation with, and critical assessment of, the historical sources. Detailed descriptions of the well preserved structures such as the gas regenerative furnaces and puddling furnace development are also recommended in order to understand the workings of these features. Additional specialist reporting has also been recommended for the metallurgy from the site. This reporting should be incorporated with the results of standing building recording in a full integrated final client report. Important findings such as the metallurgical samples results and the results from the well preserved structures are to be identified for publication in a relevant academic journal. It is also proposed that a short monograph is also produced, to fit into the existing 'ARCUS Studies in Historical Archaeology' monograph series.

1 ACKNOWLEDGEMENTS

ARCUS would especially like to thank BAM (formerly HBG) for commissioning both the field and post-excavation work and for allowing the additional strip and record to be undertaken which has added greatly to our assessment of the Site. ARCUS would like to thank Rob Kinchin-Smith of RPS and Helen Gomersall of WYAAS for their involvement in this project along with the ground crews employed by BAM (formerly HBG) and BAM (formerly HBG) themselves for their invaluable assistance in the completion of these works.

The project was managed by Glyn Davies. The excavations were undertaken by Neil Dransfield who was assisted by Tim Cobbold, Ashly Tuck, Roz Sampson, Paul Beers, Owen Raynold, Richard Jackson, John Howarth, Lauren McKintyre and Elliott Barry. The surveyor and CAD illustrator for the project was Chris Breeden.

2 INTRODUCTION

2.1 Project Background

ARCUS were commissioned in September 2006, by RPS Planning & Environment, on behalf of their client BAM (formerly HBG), to undertake a programme of archaeological evaluation and mitigation at the site of the former Monk Bridge Iron Works, Whitehall Road, Holbeck, Leeds, West Yorkshire.

These investigations formed a stage of works relating to a planning application (P/06/02280/OT) to develop the site. The full planning permission reference on Block 1 is P/06/05718/FU. On the basis of this, the West Yorkshire Archaeology Advisory Service (WYAAS) determined that the site required a programme of archaeological mitigation in advance of development. The requirement is in line with government guidance as set out in Department of the Environment Planning Policy Guidance – Archaeology and Planning (PPG16, 1990).

The site was located approximately 1km to the south-west of Leeds city centre at NGR SE 2903 3307 (**Illustration 1**). The area of Holbeck where the site was situated was a formerly heavily industrialised part of Leeds and the site itself covered only approximately half of the original extent of the former Monk Bridge Iron Works, with the remainder (now largely demolished) being situated on the opposite (south) side of Whitehall Road. The area of the wider site that is the focus of this report is bounded to the south east by Whitehall Road (formerly the Leeds to Halifax turnpike), to the south west by the embankment of the former Leeds and Bradford railway, to the north east by the River Aire and the Leeds and Liverpool Canal and to the north west by the Grade II Listed River Aire viaduct. This area is hereafter referred to as 'the Site'.

Prior to the excavation the Site was occupied by a number of recently vacated office and manufacturing buildings last used by the Sheffield forgemasters, Doncasters. The buildings ranged in date from the mid-19th to the late-20th century. They consisted of brick-built office and workshop ranges and large steel-framed sheds.

Following on from an extensive programme of historic building recording (see **Section 2.3** below), these buildings were subsequently demolished and the overlying concrete floorslabs and hard-standings broken up in advance of ground reduction ahead of the proposed development.

2.2 Historical and Archaeological Context

Much has been previously written regarding this Site and its historical setting (Fitzgerald, 2004; Kinchin-Smith, 2004). This assessment report (see **Sections 2.2.1** and **2.2.2** below) will briefly summarize the main points of this work. A fuller discussion can be found in the works previously mentioned and will be included in any further detailed reporting of the project.

2.2.1 Historical Context of the Former Monk Bridge Iron Works

The development of the engineering industry in Leeds took place within the wider context of the rapid expansion of the city, which was characterised by an industrial tradition dating to the early part of the 14th century.

From *c.* 1350 to 1750 the manufacture of woollen cloths was the characteristic industry of the Leeds area, employing a large proportion of the local population. The thriving woollen trade was further stimulated by the establishment of the Aire and Calder Navigation under an Act of 1699 and late 18th-century developments to the trans-Pennine Leeds to Liverpool canal. The city flourished as a centre of international wool textile trade providing an important foundation for the later development of engineering industries in Leeds. During the late- 18th century, the local woollen industry began to move to centralised, multi-storey factories, employing machinery to increase output.

In the second quarter of the 19th century, the local railway network grew. The rapid proliferation of lines during 'The Railway Mania' resulted in a much-increased demand for steam locomotives, both to run on the main lines and the various connected industrial systems at collieries, iron works and other sites. The established Leeds engineering firms were well-placed to serve this new market, and railway locomotive engineering grew to be a major industry on a scale only rivalled in the UK by Glasgow. The most distinctive feature of the Leeds locomotive industry was the nucleation in Hunslet of several firms specialising in the production of industrial locomotives, often relatively small, but with larger engines built for export markets.

By the end of the 19th century, the former Monk Bridge Iron Works became a location at the centre of a number of modern, mechanised industrial sites in the Holbeck area. The development of these sites was a response to an increasing demand for technological products of the latest technological developments, whether in the established woollen industry, or the dependent associated transport and mining industries which flourished as the use of steam power became widespread.

The development of Monk Bridge Iron Works was tied into the expansion of Leeds' locomotive building industry, an industry that traced its evolution from Matthew Murray's pioneering and internationally important Round Foundry nearby in Water Lane.

2.2.2 The Monk Bridge Iron Works

Against the background of a thriving local engine-building industry, The Monk Bridge Iron Works was founded in June 1851 by Stephen Witham, producing the high quality wrought iron needed by the locomotive-building and engineering industries in Leeds. The works appears to have been an immediate success and was purchased by James Kitson in September 1854, in order to secure supplies of the high quality of wrought iron needed for boiler plates, locomotive tyres, crank axles and couplings. Kitson (Later Lord Airedale) had formerly been an employee at Matthew Murray's foundry and had started locomotive manufacture on his own account in Hunslet in 1837 and

rapidly developed a highly successful company with an important export market to South America, Africa, East Indies and former UK colonies.

Under the Kitsons, steel-making using the Huntsman crucible process was introduced, initially for the manufacture of tyres for locomotives. The growth in demand for quality steel prompted the Kitsons to purchase further land to the south of the Whitehall Road in August 1864 for the construction of a purpose-built steelworks. Two huge buildings were constructed on the newly-purchased site to house the steel works and steel billet and tyre mill, first depicted in 1866.

Following the introduction of the Siemens Martin Open Hearth method of steel making in 1884, Monk Bridge quickly realised its value for railway work owing to its adaptability to meet the increasingly stringent requirements of railway and other engineers. Thus further Siemens-Martin open-hearth furnaces of increasing capacity were installed to supply the steel tyre and billet mill and by 1885-90 the plant was also producing cast-steel wheel centres.

On the death of Sir James Kitson in 1911 the company was taken under Government control and at the outbreak of the First War it supplied large quantities of material to the War Office and Admiralty.

In 1936 the works was described in print. The casting shop not only produced ingots of various sizes but also other parts both large and small for use on locomotives and rolling stock. Presses for working billets were installed of progressively larger sizes, from small forging hammers to a 2000 ton hydraulic press capable of dealing with very large ingots. The plant also included a heat treatment department with furnaces capable of heat treating large items such as axles, tyres and rings. The machine shop was capable of slicing ingots for the manufacture of tyres for locomotives, together with extensive machining and turning facilities for producing locomotive axles.

The former Monk Bridge Iron Works survived the depressions and closures of the 1920's and 1930's and was taken under Government control again during the Second War. Once peace returned it was clear that steam locomotive manufacture was slowing down and that the Leeds producers were failing to develop fast enough to remain in the vanguard of diesel and electric locomotive manufacture to retain markets at home or abroad. As a result the company was finally wound up in 1949.

In 1951 the derelict former Monk Bridge Iron Works was purchased by the Sheffield forging company Daniel Doncasters. Doncasters was established in 1778 to apply the Huntsman crucible process to the manufacture of hand tools and had grown during the 1940s into a leading supplier of forged steel tools and valves to the automotive industry and today it remains one of the longest continuously operating industrial manufacturing companies in the world. Doncasters had been involved with the production of the Whittle jet engine and were quick to understand the potential of the invention and the associated demand for forged turbine blades manufactured to the most exacting standards and tolerances. At the time of the take-over a jet-powered civilian air-liner was under test at De Havilland (the Comet) and military jet engines were urgently needed for the war in Korea. Doncasters' Sheffield plant was already busy with the manufacture of jet blades and it was decided that the Leeds site should be given over, at least in part, to the manufacture of these difficult precision components. Significant investment followed and by 1953 Doncasters Monk Bridge was rivalling its parent company in size, making virtually nothing but turbine blades. Ever larger presses were installed on the northern (former iron works) part of the site and in the period 1956-65 a number of new buildings were constructed, or existing ones reconfigured. Further investment followed in the late 1960s and early

1970s, following on the decision to manufacture the turbine blades for the Rolls Royce Olympus engine at Monk Bridge.

By the end of the 20th century the southern (former steel works) half of the site had become redundant and the buildings were demolished. By 2005, the remaining northern operations had been relocated to Doncasters' Sheffield and Wales and the Monk Bridge site was sold for redevelopment.

2.2.3 Summary of Key Historical Dates and Events

Date	Event
1851	Stephen Witham establishes a forge on the Site in order to supply the local demand for high quality iron.
1854	The Monk Bridge Iron Works is purchased by James Kitson for the sum of £21,500 to secure a reliable source of wrought iron for his Airedale Foundry locomotive works. Two additional plots of land are purchased further to the west to allow for future expansion.
1858	By this date the works had expanded to cover the full extent of the land then in Kitson's ownership.
1864	Further land was purchased to the south of Whitehall Road for the construction of a steelworks.
1886	The conversion of the Monk Bridge Iron and Steel Company into a private limited company took place.
1914	The works was taken under government control for the duration of the First World War.
1940	The works was again taken under government control.
1949	The former Monk Bridge Iron Works was closed and the company wound up.
1951	The site was purchased by Doncasters of Sheffield and rapidly became the centre of world renown for the production of forged turbine blades.
2005	The Monk Bridge site was closed and production transferred to sites in Sheffield and Wales.

2.3 Previous Work

Doncasters' site, to the north of Whitehall Road, has been the subject of three earlier studies:

- Fitzgerald, R. 2004. *An Archaeological Desktop Assessment of the Monkbridge Ironworks, Whitehall Road, Leeds*. Structural Perspectives, unpublished.
- Kinchin-Smith, R. 2004. *Monk Bridge Forge: Historic Building Assessment,* RPS, unpublished.
- Jessop O. and Douglas, M. (forthcoming). *Archaeological Building Recording of Monk Bridge Forge, Whitehall Road, Holbeck, Leeds, West Yorkshire.* ARCUS unpublished Report number 971.1 (2).

These three reports discuss the historical development of the Site, describe each building, and identify historic details considered to be worthy of further study.

2.4 Site Archives

Discarded within one of the former drawing offices on the Site (room B2F3), a very large quantity of 20th-century building and factory plans were examined. This material is currently located with the project engineers, BSCP LTD, Consulting Engineers, Smeaton House, Leeds, LS16 7SR. It is eventual intention that it is deposited with Leeds Archives. The opportunity was taken during the standing building survey to digitally scan a selection of the material. In addition, 19th-century deposited building plans held in the Leeds Archives in Sheepscar were consulted, along with various secondary sources relating to the works.

A painting which was presented to Mr Samuel Witham on behalf of his father in 1855 was examined at first hand as part of the programme of archaeological survey and recording. It was photographed in October 2006 at the Head Office of Doncasters in Melbourne, Derbyshire.

3 FIELDWORK AND POST-EXCAVATION

3.1 Fieldwork Methodology

Preservation by record was deemed by the Local Planning Authority's archaeological advisors (WYAAS) to be a suitable mitigation strategy for the redevelopment of this Site. The methodology developed within the archaeological specification combined a strip, map, record and sample methodology (ARCUS/RPS WSI, 2006; WYAAS, 2006).

Targeted evaluation areas were opened which focused on five areas (A, B1, B3, C and D - ARCUS/RPS WSI, 2006) of the Site with known or suspected archaeological potential, as derived from the results of the archaeological desk-based assessments (Fitzgerald, 2004; Kinchin-Smith, 2004), and the standing buildings appraisal (Jessop and Douglas, forthcoming). The WYAAS (on consultation with RPS and ARCUS) determined which of these areas were to be fully excavated based on the results of these preliminary archaeological evaluations (WYAAS, 2006). BAM (formerly HBG) further agreed to an extensive strip and record to be undertaken (where reasonable) within the footprints of the former buildings. The strip and record allowed the trenching programme to be assessed within a wider Site context.

All fieldwork was carried out in accordance with Institute of Field Archaeologists (IFA) standards (1997; 1999) and current best archaeological practice.

3.2 Evaluation

Machine-assisted ground level reduction was carried out, under the strict supervision of a professional archaeologist, to the upper surface of the highest archaeological deposits. A 360° mechanical excavator, with an appropriate toothless ditching bucket, was used to remove the overburden. A toothed bucket and breaker was used, where necessary, to remove any remaining modern reinforced concrete or compacted modern deposits. Machine excavation was halted at the top of the first archaeological horizon and the excavated area was cleaned by hand. Features were then hand cleaned and planned at a scale of 1:20. All features and deposits were recorded using the ARCUS standard recording system and a full photographic record was taken.

3.3 Excavation

Three of the areas (A, B3 and D) were then targeted for full excavation. The features and deposits were hand excavated (large deposits and structures were removed using a 360° mechanical excavator with the consultation of WYAAS). Sufficient

excavation to allow an archaeological understanding of the stratigraphic sequences and the character of the archaeology uncovered was undertaken.

3.4 Recording

A full written and photographic record was made of all archaeological features in the excavation areas. All features were initially planned by hand at a scale of 1:20. Where appropriate, a larger scale of 1:10 or 1:5 was employed to show greater detail. Section drawings were also drawn at an appropriate scale to define detail. Planning and section points were surveyed using a Total Station. All archaeological features were recorded using the ARCUS standard recording system. A 'site north' was established as north west (from magnetic north) perpendicular to Whitehall Road. This 'site north' was used for all site works, archive and reporting.

3.5 Strip and Record

BAM (formerly HBG) agreed to a programme of strip and record to be undertaken. These areas covered the remainder of the buildings to which the trenching programme related. Areas 1a and 2a were situated, to the north and south of Trench D, in the former puddling sheds. Areas 1b and 2b, were situated to the north, south and west of Trench C, in the former rolling mill. Area 3 was situated within the former tyre mill, effectively linking Trenches A, B1 and B3 together.

Machine-assisted ground level reduction was carried out, under the strict supervision of a professional archaeologist, to the upper surface of the highest archaeological deposits. A 360° mechanical excavator, with an appropriate toothless ditching bucket, was used to remove the overburden. A toothed bucket and breaker was used, where necessary, to remove any remaining modern reinforced concrete or compacted modern deposits. Machine excavation was halted at the top of the first archaeological horizon and the excavated area was cleaned by hand. Features were then surveyed using a Total Station and archaeological features were recorded using the ARCUS standard recording system. A full photographic record was taken.

3.6 Survey

Detailed survey work tied the archaeological investigations into the Ordnance Survey National Grid. Temporary bench marks and planning grids were also surveyed in and all drawings assigned spot heights related to Ordnance Survey Datum levels in metres, correct to two decimal places.

3.7 Sampling Strategy

A sampling strategy (ARCUS/RPS, 2006 App 1.2) for industrial residues was adhered to. Bulk samples from 30 – 60 litres were collected to assess types of fuel, processes undertaken on site, the age/construction of structures and the chemical composition of raw materials and compounds. The strategy included the specific collection and processing recommendations of metalliferous artefacts and small finds. A strategy for the analysis of this material included optical microscopy, chemical analysis, X-radiography, X-ray diffraction and particle size analysis.

4 PROJECT AIMS AND OBJECTIVES

The aims of the evaluation (ARCUS/RPS WSI, 2006) were:

- to gather sufficient information to establish the extent, condition, character and date of archaeological features and deposits within the areas specified by WYAAS containing potentially significant archaeological features;

- To determine areas of archaeological potential to be targeted for further excavation.

The aims of the targeted investigation (WYAAS, 2006a) were:

- to excavate and record the features within the targeted areas;
- to characterize and analyze a small group of features associated with heating and handling of metals on the Site, and (as far as possible) to place them in context with regard to contemporary features within the area of the iron works;
- to locate and characterize the larger features associated with metal handling and working on the Site;
- to identify archaeological evidence for the range of industrial activities that took place within the development area and to investigate the development of the Works and associated buildings through time;
- to clarify the organisation of industrial activities and use of space;
- to determine the position, extent and degree of preservation of the archaeological features identified by desk based research;
- to provide information for the importance of the remains to be assessed in relation to the non-statutory criteria set out in appendix 4 of PPG 16;
- to provide information for the development of any further mitigation strategy that may be necessary.
- to broaden the knowledge base and context of previous archaeological work in Leeds.

5 SUMMARY OF THE FIELDWORK

5.1 Site Areas

For the purposes of clarity the report is set out describing Trenches A to D (**Illustration 2**) individually but with reference to the former historic buildings in which the trenches were located. Information gained from the wider strip and record excavations (Areas 1a, 1b, 2a, 2b and 3 – **Illustration 2**) has been incorporated into the discussion of these trenches where information regarding the operations within each of the work's buildings is relevant.

Tyre Mill (**Section 5.2**)

Trenches A, B1, B3 and Strip and Record Area 3 were located within the footprint of a former tyre-mill building dating to 1861. This building was still standing at the closure of the factory and was designated as RPS Building E1 / E1.1 (**Illustration 3**). As the results from these four areas link together, a summary is provided assessing the material from these sources in an overall discussion.

Rolling Mill (**Section 5.3**)

Trench C and Strip and Record Areas 1b and 2b are assessed in a separate summary. These were located within the footprint of the work's Phase 1 (c.1851) rolling mill and subsequent extensions. Much of the building was demolished during the post-war period, although fragments remained at the time of closure, incorporated into RPS Buildings G1 and G1.1 (I**llustration 3**).

Puddling Sheds (**Section 5.4**)

Trench D and parts of Strip and Record Areas 1a and 2a fall within the footprint of the work's Phase 1 (c.1851) pudddling sheds at the east of the Site. The puddling sheds were completely demolished sometime between 1932-3 and 1944. The area was later occupied by a large, post-war factory building (RPS Buildings H1, H1.1 and H1.2 – **Illustration 3**). The remains relating to the former puddling sheds are also assessed separately.

The results and recommendation will be outlined in a statement of potential, research aims and proposal for further work in **Sections 8, 9, 10** and **11** below.

The cardinal points referred to within the report refer to 'site north' which is magnetic northwest.

Structures and deposits were assigned individual context numbers based upon the trench or recording action in which they were discovered. Structures and deposits are referred to in the text by their allocated context number. The numerical sequences are as follows:

- Trench A: 1000 – 1147
- Trench B1: 2000 – 2038
- Trench B3: 2500 – 2684
- Trench C: 3000 – 3026
- Trench D: 4000 – 4452
- Watching Brief on Electric Substation: 5000 – 5009
- Strip and Record: 6000 – 6200

A full listing of contexts is provided in **Appendix 1** below.

5.2 Tyre Mill

5.2.1 Introduction

Trenches A, B1, B3 and Strip and Record Area 3 all lay within the historic footprint of a single large building (RPS Building E1 / E1.1 – **Illustration 3**). This building survived largely intact at the time of closure and was recorded in detail during the pre-demolition building recording exercise (Jessop and Douglas, forthcoming). The building retained an 1861 date-stone and first appears on the Brierley 1866 map (**Illustration 5**). The building is thought to have been a tyre mill developed to house Kitson's patent process for forging 'weld-less' steel railway tyres. It appears to have been largely supeceded by a large modern facility built to its northeast in 1911 (RPS Buildings I4, I4.1 and I4.2). Unfortunately the apparent secrecy about the processes carried out in this building means that written descriptions of other parts of the works do not extend to the operations formerly located here.

The former building's location appears to partially overlie the site of a short-lived, narrow, two-storey north south range apparently constructed c.1851 as part of the original Witham forge (this earlier building is shown in the background of the 1855 Witham painting and on the 1858 maps of the area (**Illustration 6**). Little or no evidence of this early range of buildings was uncovered in either the trenches or the strip and record. A watching brief on the new electricity substation revealed backfilled possible cellar walls associated with the former ranges fronting Whitehall Road (RPS Buildings B1 and B2 - **Illustration 3**).

Trench A was targeted on an area of small cell-like structures shown on the first detailed 1923 factory plan (**Illustration 4**). The excavation revealed the southern extent of a chain of interlinking cranes and engine mountings [6099] that centred on the middle of the former building. The crane bases in Trench A were probably functionally connected with the transportation of materials associated with a gas regenerative furnace [6191] (see Strip and Record below **Section 5.2.5**), the brick trough/celled features found in Trench A and a very large engine or machine mounting [6099] found in the Strip and Record Area 3 (**Plate 1**).

On the eastern side of the middle of the building Trench B3 was targeted on what was thought to be an engine house. Enlargement of the trench revealed the below-ground remains of an extremely well preserved gas regenerative furnace and flue system. Located to the north were the foundations of an open ended building or room which partially retained the foundations an engine mounted on sandstone blocks. This engine was related to further machine or engine mounting blocks and further crane bases found to the east, which may have been designed for the production and handling of locomotive tyres.

The whole of the former RPS Building E1 appears to have served the same or similar functions, with little apparent modification, from the 1860s until the 1930s. Part of the building latterly housed an electro-chemical plant, evidence of which was identified within the later phases of Trench B3.

5.2.2 Trench A

Trench A measured over 15m x 7.5m (**Illustration 7**). A maximum depth of 1.2m was achieved to the top of the natural soil level.

Trench A (**Illustration 7, Plate 2**) was located within the southern end of former RPS Building E1, located to the north of the office and ancilliary ranges fronting Whitehall Road (**Illustration 3**). Its purpose was to investigate a U-shaped cellular structure shown on the 1923 factory plan, proposed as the upper part of a possible crucible furnace by Fitzgerald (2004). On excavation the initial interpretation of the cells was found to be erroneous. The structure, however, remains enigmatic and the results of the excavation are listed below.

Phasing of Trench A

Datestone evidence shows that RPS Building E1 was constructed in 1861. Although the excavation revealed alterations to the area over time, it is not possible at this stage to precisely date these changes. Suffice it to say that the full range structures uncovered were possibly still in use in 1923, or only recently out of use, as all elements are shown on the detailed factory plan of that date (**Illustration 4**).

- Phase 1: small crane base with c.5.25m reach arc covering a rectangular red-brick structure containing four internal troughs or elongated cells (A) situated to the east of the crane.
- Phase 2: an additional rectangular red-brick 'trough' structure (B), located just to the west of the small crane.
- Phase 3: two separate brick structures containing a number of brick cells (C & D) are appended to the south of both of the existing trough structures and a larger crane base with a reach arc of c.6.75m is butted onto the eastern edge of walling associated with 'trough' structure (C).
- Phase 4: the structures within the area are demolished and then voids are

purposefully backfilled with industrial waste, apparently to create a level floor surface. This may have occurred during the 1930/40's, as the building is shown as largely empty in plans from the 1930s and 1944 (Kinchin-Smith, 2004, Figs 20 and 21).

Phase 1; Small Crane Base and 1st Rectangular Trough Feature (Structure A)

The natural ground consisted of a yellow brown sandy clay 1128.

The first phase of activity was represented by a large block of sandstone 1036 measuring 1.3m square and its sandstone foundation 1127. A slight squared recess of 0.6m x 0.45m and a small fixing bolt suggest its use as some form of machine mounting. Its location precisely overlay a crane base shown on the 1923 historic map. The crane had a reach arc of around 5.25m which encompassed the locations of structures A and B (see below) and possibly the southern end of a exceptionally large sandstone engine or machine base 6149 uncovered to the north west during the strip and record exercise (**Illustrations 4, 7** and **Plate 2**).

Situated 1m to the east of this crane was a rectangular walled red-brick structure (structure A) measuring 3.4m x 3m which contained a series of parallel internal walls 1025, 1024, 1023 aligned east to west (**Illustration 7** and **Plate 2**). The structure was built on top of a 0.08m thick surface of clinker and rubble 1131 and 1076 presumably laid to create a flat construction surface above the natural. These walls effectively formed four long rectangular troughs which measured approximately 2.9m x 0.6m. These troughs contained a mortared floor at the base 1075 and 1066 which were initially covered by layers of greenish black sooty, silty sand 1022, 1031 and 1074. Although the bricks showed a degree of erosion they were unaffected by heat. They appeared to be hand made and bonded by a white lime mortar with some charcoal inclusions.

These features were then surrounded by several distinct layers of made ground around 1m deep consisting mostly of industrial clinker and silts. These deposits effectively raised the ground level up. These deposits also formed the ground level for the majority of the Strip and Record Area 3 area within former RPS Building E1.

Phase 2: Additional Rectangular Troughs (Structure B)

Additions to the small crane base noted above took the form of a 0.65m thick brick surface 1122 and an orange brown sandy clay 1124 packing.

1m to the west of the small crane base another block of red-brick 'troughs' (Structure B) was excavated. This group measured 2.3m x 3.45m, containing three 'troughs' with internal dimensions of 3.1m x 0.45m (**Illustration 7**). The 'troughs', similar to those in phase 1, were cut 1145 through the initial made ground. These troughs were sat on a thin lens of mortar 1121 and a metalled layer 1120, which presumably created a level construction surface. They were initially filled by blackish silty sands 1119, 1146 and mortar 1147. Pottery of an 18th-century date from 1120 (**Section 6.2, Appendix 3 - Tables 8** and **9**) suggests that the material may have been imported into the Site from elsewhere. The brick and mortar type was similar to those of Structure A, suggesting that the two structures may not have been built very far apart in time.

The made ground was then re-consolidated by another layer of clinker material 1046. No pottery dating after the 18th to mid-late 19th-century (**Section 6.2, Appendix 3 - Tables 8** and **9**) was uncovered in this deposit which is consistent with the suggested dating of this change to the later half of the 19th-century.

Phase 3: Large Crane Base and Small Brick Celled Structures (Structures C

and D)

Bonded to the east side of the first phase rectangular structure (Structure A) by a more modern type of brick walling 1002 was a large crane base (**Plate 3**) precisely on the location of the more southerly crane evident on the 1923 plan (**Illustration 4**). The crane base, which was constructed from five blocks of sand stone, measured 3.5m square. At the centre of the structure was a large central hole (0.6m square) containing a 0.4m diameter metal rod. Six roughly circular holes and fixing bolts within these blocks and a circular groove in the upper surface, measuring 2.6m in diameter, were evidence of the basal structural elements of the crane itself. The sandstone blocks contained short lengths of brick walling set into the shaped blocks at each corner (**Illustration 7**). The 1923 map suggests that the crane had a reach arc of some 6.75m which would have encompassed the closer parts of structures A and C, as well as a gas regenerative furnace 6191 butting the south of the crane, and the southern portion of a long (11m) series of parallel sandstone machine bases 6099 which may have had a number of separate machines sat on top. This engine / machine base also overlapped with the 6.5m reach arc of the smaller crane 6101 (**Illustration 4**).

Wall 1002 also formed the eastern wall of a rectangular brick structure (Structure C) measuring 3.8m x 1.7m, which was abutted onto the upper surviving southern wall of the first phase rectangular structure (Structure A) and bedded onto a flat brick floor 1065 (**Illustration 7, Plate 2**). Cuts 1138 and 1140, show that the construction occurred after the second made ground episode and were backfilled by similar clinker material 1139, 1142 and 1141. This later structure contained ten square brick walled "cells" within. These cells were roughly 0.6m x 0.55m x 0.5m deep. Initial fills were of thin layers of blackish clayey silts which contained pottery dating between 1840 and the late 19th century (**Section 6.2, Appendix 3 - Tables 8** and **9**).

A similar rectangular brick structure (structure D) measured 4.8m x 3m and contained eighteen brick cells 1079 similar to those mentioned above (**Illustration 7**). It sat above a concreted foundation 1117. The construction cuts 1132 and 1143 demonstrate that this structure cut through the second made ground event and were also filled by a mix of silt and clinker 1134, 1133 and 1144. The construction of this structure also cut through a flat brick surface 1033 which was laid on top of the second made ground episode.

Phase 4: Demolition and Backfill

The final phase here was represented by a series of industrial waste and rubble fills within the features themselves which underlay the concrete and rubble overburden 1000 that had comprised the modern floor of former RPS Building E1. Deposits of black silty sand with large slag lumps were located in the second phase rectangular troughs (Structure B). Deposits of brown silt and brick rubble (from the structure itself) were located in the western later brick "cells" (Structure D). Deposits of dark greyish brown silty sand with large slag lumps were located in the eastern later brick "cells" (Structure C). Finally, deposits of blackish brown silty sand and large lumps of slag and brick rubble were located within the first phase rectangular troughs (Structure A). A large cement sump 1110 was inserted at the northern end of troughs B and was presumably contemporary with the modern concrete floor slab 6150 which overlay the earlier engine mounting 6149 (**Illustration 4**). Pottery within the fills of all of the troughs had a wide date range from the 19th to early 20th-century (**Section 6.2, Appendix 3 - Tables 8** and **9**).

5.2.3 Trench B1

Trench B1 was approximately 6.5m x 6.5m. A maximum depth of around 0.6m was achieved. The evaluation did not go to full excavation (**Illustration 8**).

Phasing of Trench B1

Trench B1 was located at the north-western corner of former RPS Building E1 (**Illustration 3**), noted as the probable location of an engine house by Fitzgerald, 2004).

- Phase 1: consisted of the sandstone foundations of the north and west walls of the probable engine house located in the northwest corner of the former RPS Building E1, together with the truncated remains of a sandstone engine mounting. Butted onto the west of the probable engine house was room were the below-ground remains of a gas regenerative furnace and probable flue cellar which was housed within a long-demolished range of buildings at the north of former E1 (within later RPS Building I2.1). During the subsequent strip and record exercise, a possible tyre blocking press, along with a range of features relating to the operation within former RPS Building E1 were uncovered to the south and east of the former engine house, outside of the limits of the original Trench B1.
- Phase 2: consisted of a major drainage or pipe installation which truncated the walls of the engine house and a series of made ground and concrete levelling dumps with modern walling which may relate to alterations during the Doncasters ownership in the 1950's.
- Phase 3: consisted of a remnant of additional walling and an upright possible girder or column support which was located along the western wall of RPS Building E1, at the northwest corner.

Phase 1: Furnace, Engine House

The earliest phase identified in this trench comprised two main structures. At the very west of the trench, and extending further west beyond its limits, was a north-south aligned, fire brick structure, which was reminiscent of an end (or hot air) chamber of a gas regenerative furnace, as uncovered within Trenches B3 and D. The feature measured 3.5m long x 1.8m wide, consisting of external walls 2001, 2004, 2005/2014/2038 and a demolished arched roof 2003, 2004 (**Illustration 8**). The internal dimensions of the chamber were 2.5m x 0.8m, which is 0.3m shorter than the gas regenerator in Trench B3 but roughly the same width. The northern end of the structure was encased in a red sandy deposit 2031 which was presumably an encasing deposit which was subjected to a great deal of heat. Keyed into the south end of the structure was an extension of the eastern furnace wall 2006, 2007, 2008, 2010 and an east–west return 2012 which effectively formed an ante-room or cellar to the south of the furnace. Similar structures relating to the other gas regenerators on Site suggest (see Trench B3) that this may have formed cellarage above a flue system channelling gas into or from the furnace. The above-ground portion of the furnace is evident as a rectangle (just to the north west of trench B1) on the 1923 factory plan (**Illustration 4**) as well as on the 1930s and 1944 factory plans (Kinchin-Smith, 2005, Figs 20 and 21). The furnace would appear to have been located within an east-west range of buildings that abutted the northern end of former RPS Building E1. This east-west range is first shown on the Brierley map of 1866 and appears to have continued in use (latterly equipped as a heavy forge with three massive hammers or presses) until closure of the Monk Bridge Iron and Steelworks in 1949.

Abutting the eastern side of the furnace and cellar were two substantial sandstone wall foundations 2011, 2015 which formed the west and north walls of the supposed engine house building, which measured at least 3.9m square (**Illustration 8**). These foundations clearly match up with the western and northern walls of the building located in the north west corner of RPS Building E1 in 1923 (**Illustration 4**). Within this building were three large sandstone blocks 2017, which appear to have formed part of an engine or machine base. Abutting the internal face of the northern wall foundation were a series of red and fire brick fragments and a small sandstone block 2019, 2020, 2021, 2022, forming a small rectangle, which extended beyond the eastern limit of excavation. The function of this rectangular structure is unknown.

Clearly there was no surviving evidence regarding the original height or appearance of this building, but the above-ground parts of this building were recorded as part of the standing building survey (Jessop and Douglas, forthcoming - Plate 205). The building record may also clarify the demolished remains of the small modern wall stub (see 2023 below). There would seem to be scope for reconciling the above and below-ground record as part of additional reporting.

Phase 2: Drainage & Later Additions

Truncating the north west corner of the sandstone wall foundations of the probable engine house, were two 0.13m (5") diameter metal pipes which ran into the building. Pipe 2035 ran adjacent to the eastern wall, also truncating the engine base (**Illustration 8**). Pipe 2037 ran adjacent to the northern wall and was subsequently truncated after some 1.6m at its eastern end. Outside the building at the north west corner the pipes fed into a small brick modern frogged brick manhole bonded by modern cement 2024, 2025, 2026. A small gap between these walls to the east and a small section of walling 2027 aligned east to west suggests that the pipes may have continued along the outside of the building's northern wall.

Within the building and butting the early engine base were two surviving modern concrete blocks 2016, 2018 which overlay the drains. Their purpose is unclear at this stage but they may have formed part of a base for a later engine or the post-war reconstruction of the forge. Probably contemporary with these were was a 3.1m x0.8m x 0.9m thick poured concrete deposit 2028 which formed the support foundation for a modern brick wall 2023.

Phase 3: Made Ground and Modern Walling

The final recognisable phase consisted of a series of demolition and reconstruction deposits. Deposits 2030, 2032 and 2033 overlay the structures in the eastern part of the area and consist of a mixture of clinker, rubble and silts. Deposit 2034 lay within the remains of the furnace chamber and the cellar consisting of a mid greyish brown clayey sand containing CBM, slag fragments and containing pottery of a mid-late 19th - century date range (**Section 6.2, Appendix 3 - Tables 8** and **9**). A fragment of north-south aligned modern walling 2013, along the line of the western wall of RPS Building E1, and an upright metal column or girder 2036, located in the backfill of the gas regenerator to the north of this, probably related to a later reworking of the work's buildings. These may be reconcilable with the standing building survey (Jessop and Douglas, forthcoming).

5.2.4 Trench B3

Trench B3 measured 12.5m x 10m. A depth of 2.3m was achieved within a set of below-ground gas regenerators (**Illustrations 9** and **10**).

Phasing of Trench B3

The trench was initially located to evaluate Engine House No.3 (Fitzgerald, 2004), situated halfway along the eastern side of former RPS Building E1. Historic remains were found beneath a number of overlying structures, which appear to have been associated with the later Doncasters electro-chemical shop. The excavations also revealed the below-ground remains of an exceptionally well-preserved gas regenerative furnace with associated flue cellar, which appears to have been contemporary with the adjacent former engine house. The results are given below.

- Phase 1: consisted of the well-preserved below-ground remains of a gas regenerative furnace, with associated flue cellar abutting its southern side. To the north of this furnace was a walled engine house which appears to have been partially open on its western face. Within the open western wall were the remains of sandstone engine foundations, including a fly-wheel pit inside the opening. The engine foundations appear to have been integral with a network of similar machine-base structures connected to the operations contained within the former RPS Building E1.
- Phase 2: consisted of demolition backfills and concrete surfaces, which probably formed the flooring inserted during Doncasters' post-war reconfiguration of the Monk Bridge work's. A number of small rectangular sump-like structures were identified which may relate to the electro chemical shop evident here during the Doncasters ownership.

Phase 1: Gas Regenerative Furnace, Flue Cellar and Engine House

A large rectangular brick structure aligned east-west, with four internal chambers was uncovered towards the southern half of the area (**Illustration 9**). The structure is shown on the 1923 factory plan as a large rectangle (**Illustration 4**). The structure measured 7.1m x 3.5m x 2.3m deep. The basic elements of the construction consisted of four north-south aligned chambers, each 2.2m long (**Plate 4**). The two outer chambers were narrower than those on the inside measuring 0.9m and 1.3m respectively. The basic construction consisted of four red brick external walls 2522, 2606, 2602 and 2512 with a firebrick interior skin 2595 and interior firebrick walling forming the internal chambers of the furnace. Above the internal chamber walls were the remains of arched firebrick roofs. Within these were set inlet/outlet flues 2581, 2582 and 2583 which were sampled for archaeometallurgic analysis (**Section 6.5**). A fragment of firebrick walling 2501 set onto the upper outer wall suggests that the upper furnace above the vaulted chambers was encased by higher external walling. Each of the chambers was filled by a lattice, or checkerboard, pattern of fire-bricks 2601, 2600, 2599, 2598 (**Plate 5**) which measured 0.225m by 0.11m by 0.06m and were supported by larger firebrick supports 2617 and 2603 which measured 0.628m by 0.225m by 0.076m. These larger firebrick supports were laid across and along the chamber bases. It is interesting to note that the squared air holes or gaps between the chequerboard pattern were narrower in the two outside chambers, compared to those of the inside pair (measuring 0.16m x 0.12m and 0.18m x 0.16m respectively). These chequerboard bricks had highly vitrified surfaces, demonstrating that they had been subjected to an extreme heat during their working lifetime. The two outer chambers were more highly vitrified than the two inner chambers.

The remains described above are clearly the below-ground air and gas chambers of a large regenerative furnace. To the immediate south of this was an associated 2m wide rectangular cellar. The north wall of this was the southern external wall of the regenerator chambers, whilst its south, east and west sides were defined by red

brick walls 2612, 2647 and 2681. The north wall contained four bricked up access doors 2604, 2607/2605, 2682 and 2684, which allowed access to the inside of each of the regenerator chambers described above. Presumably these access doors allowed the replacement and repair of the chequerboard bricks within the chambers and were bricked up afterwards to allow the furnace to be brought back into use. The southern wall 2681 contained a flue culvert 2668, which ran from an L-shaped brick flue culvert 2646 = 6182 and end wall 2661, located along the outside of the southern cellar wall. These were uncovered in more detail on the Strip and Record Area 3 (see **6182** on **Illustration 4**). Within the interior of the cellar was firebrick flooring 4662, into which a series of up to 0.5 metre high flue inlet voids, flues and arches were incorporated. These flues were evident as a parallel series of square voids in plan (**Illustration 9**) and were incorporated into the lower parts of the northern cellar wall allowing air to pass into and out of the chambers (**Plate 6**). The entire flue system was covered by a three-course thick brick floor 2650 showing signs of substantial heat damage to the central portion. Nothing remained of the former furnace that was located above the regenerative chambers, except for two large steel girders 2615 and 2504 (see **A** on **Plate 4**) abutting the north wall of the cellar. No evidence survived of the mechanisms that allowed air to be heated/re-heated and distributed into, around and from the flue system.

Other fragmentary evidence of north–south walling 2524, 2523, 2525, 2611, an east–west wall 2611 and clinker deposit 2609 butting the east of the gas regenerator may provide evidence of walls, floors and a possible flue which may be more fully assessed as part of a full report.

The northern half of the area was dominated by sandstone foundations of the southern half of a brick-walled building measuring 6.5m from east to west and at least 2m from south to north (**Illustration 9**). Situated just north and south of the building's western wall were two sandstone foundation blocks, each with the truncated base of a cast-iron column 2634 and 2573. These indicate that the engine house stood within a separate room within the Tyre Mill Building (RPS Building E1/E1.1). Incorporated into the western side of the engine house, some 2m from the south-western corner were two parallel sets of large sandstone foundation blocks, set 0.7m apart, which were probably the base of an engine or machine. Blocks 2655, 2574, 2620 and 2621 formed the northern 'arm' and blocks 2658, 2567, 2566 and 2565 formed the southern 'arm'. The blocks measured at least 4m long x 0.5m wide, extending some 1.8m inside the building. The blocks each had a recessed gap towards the eastern end which may have housed an axle or other structure. A layer of black greasy material 2619 covering the lower parts of these mountings within the building's interior may substantiate this. The upper surfaces had bevelled edges, which continued onto the upper surface of sandstone blocks 2569, which were bonded to the west of these mountings (**Illustration 9**). The strip and record revealed that structure 2569 was composed of four blocks of sandstone 6105, measuring 3.45m x 3.25m in total, containing a trapezoidal-shaped arrangement of four fixing holes and pins, widening toward the two parallel 'arms' (**Plate 7**). The engine (or machine) base lay just outside of the radial arcs of sandstone crane-base foundations 6101 and 6113 to its west and north respectively (**Illustration 4**). The engine base structure may also have been supported on an L-shaped wall, of frogged bricks bonded by a black ash mortar 2651, 2597 and 6111. The resultant void created between the walling and sandstone blocks may indicate the presence of a wheel pit in this location. Wall 6111 in turn abutted an 11m-long parallel set of sandstone machine-foundation blocks 6110, which would have run down the centre of the former work's main building (**Illustration 3**, RPS Building E1).

The voids between the structures were filled by a series of deposits 2645, 2644, 2638, 2643, 2618 and 2656, presumably to create a level surface for the original flooring.

All of the structures noted above correspond with features shown on the 1923 factory. RPS Building E1 is shown virtually devoid of machinery in the 1930s and 1944 factory plans. The lack of evidence of alteration or earlier structures implies that this phase of activity belongs to the expansion of the Witham forge under the Kitsons in the early 1860s, as depicted on the Brierley 1866 map. The facilities appear to have remained unchanged prior to the decline of the factory in the 1930s.

Phase 2: Drainage and Later Alterations

At some point prior to the later features (see below), probably in the 1930s, the north and south walls of the engine house building, engine and machinery were demolished and any voids purposefully backfilled with a silty clay deposit 2589 containing a high percentage of large slag lumps and CBM. The gas regenerator and cellar were also partially demolished and backfilled. The RPS Building E1 is shown virtually devoid of machinery on the 1930s and 1944 factory plans and the building appears to have been little used by the Ministry of Supply in the 1940's. A large programme of drainage works was subsequently undertaken in the area of this trench. Three manholes were constructed located around the area. These linked up to a network of piping, overlain by a brick surface 2630 which in turn supported two small rectangular tile-lined sump features (**Illustration 10**). The sumps were filled with silty sands containing small round pebbles 2650 and 2556 and surrounded by concrete slab flooring, which sealed the majority of the northern half of the trench. These appear to have been connected to the electro-chemical shop, which was present here from the 1950 until closure of the Doncasters works. There appear to be at least two later phases connected with the electro-chemical plant as later piping 2657=2562, 2564 and 2563 appears to truncate the concrete flooring. Further work correlating the survey data to factory plans may confirm a more precise dating for these changes.

5.2.5 Strip and Record Area 3

Virtually the whole of the footprint of former RPS Building E1 / E1.1 was uncovered during the strip and record exercise that followed the purposive excavation of Trenches A, B1 and B3. These excavations identified and recorded 68 individual features and revealed a very good level of general preservation, particularly of large machine and crane bases (**Illustration 11**).

The key features were the footings of three 5.75m reach crane bases 6113, 6134 and 6115, and the footing for a 6.75m reach crane 6101. Also uncovered was an area of massive, interconnected sandstone machine bases 6099, 6181, 6102, 6105 and 6110 filling the central part of the building (**Illustration 11, Plate 1**). These bases were clearly associated with the probable engine base located in Trench B3 and formed the foundation for very substantial machinery that lay at the heart of the primary production process carried out within former RPS Building E1 / E1.1. A characteristic of particular note was that virtually every major feature revealed corresponded with equipment shown on the 1923 factory plan.

Other features of note were the probable puddle furnace bases 6179 = 6124 and 6121 (**Plate 8**). This structure has the characteristic bottle shape of the puddling furnace bases uncovered in Trench D and similar dimensions (3m long by 1.8m wide in total). The structure was located just to the north of walling 6122 and 6123 which appears to form an entrance between RPS Buildings E1 and 12.1 and 13.1. Internal walling 6129,

6139-6148 that has been uncovered (**Illustration 11**) could also be potentially tied into the Standing Building Appraisal and could also indicate developments within the former RPS Building E1 / E1.1 itself. These could be examined in further detail as part of further works.

Located 1m to the south of Trench B1, a double concentric ringed brick structure 6094 and 6095 was recorded during the strip and record phase (**Illustration 11**). This feature is shown on the 1923 factory plan and has been tentatively interpreted as the base of a possible tyre blocking press (Fitzgerald, 2004). The outer structure measured some 4.1m in diameter and consisted of a number of blocks of brickwork linked by a single skinned wall. At the centre of this structure was a 2m diameter brick-walled structure with a D-shaped internal edging. Three large iron fixing bars and a recessed groove around the inner upper surface suggest rotating machinery located on top of this inner structure. The outer edge of the inner structure contained a series of horizontal iron spindles, which appeared to align with the outer walls' brick blocks (**Illustration 12, Plate 9**). Pottery within the demolition backfill of this feature 6096 (**Section 6.2, Appendix 3 - Tables 8** and **9**) had a date range of late-19th-century to early-20th century which suggests that the feature was in operation till at least the early-20th century.

It is tentatively suggested here that the internal structure may have held the locomotive wheels in place whilst the heated tyres were placed over and around these. However, further research into the mechanics of this process would be necessary to confirm or refute this initial interpretation.

5.2.6 Assessment of the Tyre Mill Area

The area represented by Trenches A, B1 and B3 and Strip and Record Area 3 is of interest for a number of reasons. Firstly, whilst the historic use of the building remains unclear, it is apparent from both the scale of the building and its machine bases the building and the processes it contained were an important part of the overall work's complex. The building was one of the very first major additions carried out by the Kitsons after their acquisition of what had only been a conventional wrought-iron works in 1855. Unfortunately the building was built too early to require the deposition of building plans and there is a resounding silence about its use in the otherwise fulsome contemporary written descriptions of the processes carried out at the Monk Bridge Iron Works. Fitzgerald (2004) suspected that the silence may have been because the building housed a steel plant. It now seems probable that the building was purpose-built to house Kitson's patent process for forging 'weld-less' tyres for railway wheels.

Whilst the lack of easily accessible contemporary documentation is frustrating, the former building is of interest 1) because it was recorded in detail during the building recording phase of works and 2) because almost all of its below-ground remains survived intact to be recorded across virtually the whole building footprint. Fortunately the almost complete lack of historic features that are not shown on the 1923 factory plan indicates that the former RPS Building E1 / E1.1 was built and largely equipped in a single phase, and that the process it housed was thereafter subject to only minor change until the building was largely stripped internally sometime between 1923 and the 1930s.

There would appear to be no merit in carrying out further work regarding the post-war Doncasters period as the later below-ground remains were sparse, largely un-diagnostic and appear not to add anything to what is already known from other sources.

5.3 The Rolling Mill

5.3.1 Introduction

Unlike RPS Building E1 / E1.1 above, which remained little altered from the time of its construction (1861) to the time of its demolition (2005), the former rolling mills of the Monk Bridge Iron Works latterly survived only as a few fragmentary remains incorporated into later buildings. Its northernmost end was demolished as early as 1911, when a new tyre mill (RPS Buildings I4, I4.1 and I4.2 – **Illustration 3**) was constructed. The subsequent installation of massive forging presses in this later building following Doncasters' take over of the site meant that the archaeology of the northern part of the rolling mill had effectively been destroyed.

No early detailed plans of the rolling mills are known to survive, although they are shown on the detailed 1855 Witham painting of the Monk Bridge Iron Works, provisionally dated to 1854-5. The physical evolution of the mill buildings between 1851 and 1911 has been well documented by Fitzgerald (2004), drawing particularly on deposited building plans dating from 1879 and 1881 (Fitzgerald, 2004, Fig 17). These documents, combined with reliable mapping (e.g. the c.1888 OS 1:500 map) show that the primary rolling mill was extended to east and west in phases in the 1870s and early 1880s (Fitzgerald, 2004, fig 17), subsuming the original No.1 engine house within the widened mill. Deposited building plans for most of these extensions survive, each showing details of adjacent parts of the primary rolling range (Fitzgerald 2004, Figs 18-21). The northern third of the rolling mills were demolished c.1911, when the tyre mill was greatly extended (Kinchin-Smith, 2004, RPS Buildings I4, 14.1 and I4.2. see **Illustration 3**). The internal equipment in the remainder of the rolling mill survived to be recorded on the 1923 factory plan but was removed soon after. The buildings survived unaltered until the 1950s, when the former rolling mills were subject to demolition and reordering. Some fragments of the surviving buildings survived incorporated into later buildings (notably RPS Building G1 and G1.1) until final demolition. These fragments and later phases of alteration and rebuilding are covered in a detailed record of the surviving portions in the standing building survey (Jessop and Douglas, forthcoming).

The operation of the rolling mills is described in detail in written descriptions dating to c.1887 and c.1905 (Kinchin-Smith, 2004, Appendices 1 and 2).

5.3.2 Trench C

Trench C measured 10m x 6.5m and was located to assess Engine House No. 1 (Fitzgerald, 2004). The site lay at the north-western corner of former RPS Building G1 (Kinchin-Smith, 2004) (**Illustration 3**). By the normal conventions of factory plans, 'Engine House No. 1' would have been the first engine house constructed on the Site and would doubtless date to the period of Witham ownership (1851 to 1854). The engine house was located on the eastern side of the primary rolling mill of the Witham factory, abutting the west end of the primary puddling sheds and was subsequently subsumed into a widened mill. Whilst stripped of machinery sometime between 1923 and the 1930s, the engine house survived into the 1950s, first as an ARP control room and latterly as 'Brinell Dept'.

Phasing of Trench C

Despite the extension of the rolling mill in the 1870s and 1880s there appears to have been little alteration to the primary equipment, the original equipment apparently being augmented rather than replaced. Only two main phases were thus identified.

- Phase 1: consisted of a squared sandstone block engine mounting and brick walled wheel pit aligned north-south.
- Phase 2: consisted of the foundations of a series of modern walled structures. These later features clearly truncated the western end of the former puddling sheds, east of the former engine house.

The Strip and Record Areas 1b and 2b revealed many structures (including engine mountings, hammer bases, chimneys, a gas regenerative furnace and walling) relating to Phase 1. The strip and record exercise also revealed several large, deep post-Second World War concrete structures resembling large sumps.

Phase 1: Engine Mounting and Wheel Pit

The first phase uncovered within this trench was dominated by a partially revealed structure constructed 3001 from four large sandstone slabs or blocks forming an engine base, measuring 3.5m x 1.8m (**Illustration 13**). Within the top of this structure were four holes and fixing bolts, describing a square some 1.3m square (**Plate 10**). The engine base structure was abutted on the north by a series of brick and sandstone wall foundations 3006, 3008, 3007 and 3009=3010 which formed a 3.35m long, 0.75m wide northern wall. Returning from this wall, at the north east corner, were wall foundations 3011, 3013, 3015 and 3014, forming the foundations of a 3.2m long 0.8m wide eastern wall. A remnant of an east-west wall foundation 3002 to the south of blocks 3001 indicate that the whole length of this wall would have been around 4.5m in total. The gap between the east edge of engine base 3001 and the eastern wall created a void which measured 3.5m x 0.8m which has been interpreted as a wheel pit and was subsequently filled by a yellowish brown sandy fill 3025 with sandstone fragments, slag and gravel. A single sandstone block 3012 overlay the eastern wheel pit wall and lined up with the fixing bolts within the engine base suggesting a function as a support for an axle. The earlier type of handmade red brick with white lime mortar suggests a Phase 1 origin for these features.

Phase 2: Later Buildings

The eastern half of the trench (**Illustration 13**) was dominated by modern brick and concrete foundations. These were characterised by concrete footings and wall foundations of red frogged brick, bonded by a light grey cement. The foundations appeared to describe a 6.2m by 4.2m building 3026, 3023 and 3019, within which was a smaller feature or building 3020, 3021, 3022 measuring 2.7 x 2.1m. This may have been an interior room or ancillary building. Running some 0.7m parallel to the larger building on its western side was another similar wall 5.6m long. All of these features clearly belonged to buildings which were associated with the reconstruction of the former rolling mills by Doncasters in the post-war period and had quite clearly truncated the most westerly of the puddling sheds structures (**illustration 14**).

The entire trench had been levelled by a dark brown silty sand and clinker deposit containing rubble 3024 which was evident between all the structures in the trench.

After the removal of the engine from the engine house the interior had been levelled by clay 3003 before concrete slabbing 3001, 3004 and 3005 was laid around and over it.

5.3.3 Strip and Record Areas 1b and 2b

The strip and record exercise within Areas 1b and 2b to the north, west and south of the former engine house revealed an extremely good degree of survival (**Illustration 14**). The below-ground remains of a steam hammer 6023/4 and 6195 (located to the

south of the engine house in Trench C – **Plates 11 and 12**) and a continuation of massive engine mountings 6031, 6021 6020, 6035 and 6036 (**Plate 13**) which are likely to represent the foundations of a series of rolling stands and a rolling engine uncovered in Trench C (3006-3015) were also revealed. Other features of note were a gas regenerative furnace, sandstone machine bases 6015-6020 (**Plate 14**)and 6040-6043, two chimneys 6037 and 6070 (**Plate 15**) and a large a crane base (**Plate 16**) with a radial arc of 3.6m 6068 (see **Illustration 14**) These, and later features noted, such as a series of large concrete foundations 6062, 6063, 6073 and 6071 (A-D on **Plate 17**), will be worth exploring more fully, with reference to extant factory plans and the results of the standing building survey (Jessop and Douglas, forthcoming).

Whilst there are no known historic photographs of the inside of the rolling mills, the early 20th-century view of the puddling sheds (Fitzgerald, 2004, Plate 25) clearly shows the steam hammer to the north of the engine house. The use of these hammers within the puddling and forging process is described in some detail in the 1887 and c.1905 descriptions of the Monk Bridge Iron Works (Kinchin-Smith, 2004, Appendices 1 and 2) and is an integral part of the process of wrought iron production. These early remains would repay further study within a full report.

A characteristic of particular note was that virtually every major feature corresponded with equipment shown on the 1923 factory plan (**Illustration 14**). The principal features not shown on the 1923 plan are those within Area 2b, to the north of the engine house, as this part of the rolling mill had been demolished and built over with a large tyre mill in 1911. The features in this area are thus of particular interest due to the lack of any surviving factory plans showing the equipment in this part of the rolling mills prior to the building's truncation in 1911.

5.3.4 Assessment of the Rolling Mill Area

The area represented by Trench C and Strip and Record Areas 1b and 2b is of interest because of its very good below-ground preservation, because it incorporates the first phase rolling mill built for Witham in 1851 and because good written descriptions are available of it working c.1887 and c. 1901-5. Key identifiable structures such as the rolling stands and steam hammer bases would merit further analysis, illustration and description. The almost complete lack of previously un-mapped features appears to indicate that the rolling mills were generally enlarged and augmented in their working life, with little alteration of earlier equipment, right up to the abandonment or wrought iron production sometime between 1923 and the 1930s.

There would appear to be no merit in carrying out further work regarding the post-Second World War Doncasters period as the later below-ground remains were sparse, largely un-diagnostic and appear not to add anything to what we already know from other sources.

5.4 The Puddling Shed

5.4.1 Introduction

Like the rolling mills the former puddling sheds formed part of the Phase 1 Witham ironworks. Unlike RPS Building E1 / E1.1 and the former rolling mills discussed above, not even fragmentary remains of the former puddling sheds survived to be included in the pre-demolition building record. The sheds appear to have been demolished between the survey for the OS map in 1932-3 and a factory plan of 1944.

Like the rolling mills, no early detailed plans of the puddling sheds are known to survive, although they are shown (including some interior detail) on the Witham

painting of the Monk Bridge Iron Works, provisionally dated to 1854-5. The sole deposited building plan known shows the insertion of an additional chimney in 1881 (Fitzgerald, 2004, Figs 22 and 23). We are nevertheless fortunate that the 1923 factory plan (Kinchin-Smith, 2004, Fig 19) and shows the interior of the building in detail. This plan is augmented by a very detailed historic photograph of the interior (Fitzgerald, 2004, Fig 25) and descriptions of the production process written c.1997 and c.1900-5 (Kinchin-Smith, 2004, Appendices 1 and 2). Fitzgerald (2004) also contains historic exterior views (Figs 24 and 34).

5.4.2 Trench D

Trench D measured approximately 22m x 18m. A depth of some 2m below ground level (BGL) was achieved in several locations. The trench was located within the footprint of a pair of parallel ranges of puddling sheds that were latterly separated by a line of six large chimney stacks. Early maps from 1858 show a single range of buildings (**Illustration 6**). Twin ranged sheds are indicated on the Witham painting, the 1866 Brierley map of 1866 (**Illustration 5**), and later, on the 1881 Great Northern Railway map of 1882 and the O.S. 1:500 map of 1888 (**Illustration 15**).

The summary below refers to the archaeological sequence as uncovered.

Phasing of Trench D

- Phase 1: the earliest structures uncovered were two pairs of substantial parallel sandstone foundations which probably formed the south and north respective walls of each of the twin ranged puddling sheds of the Witham work's. The eastern pair of walls was linked by further sandstone cross struts which were in turn linked by further cross struts. Severe heat damage, evident on the cross struts, suggests that some form of boiler or heat exchange system linked to the puddling operation within the sheds was located here. Two substantial chimney bases were also located at the eastern end of each of the paired walling.
- Phase 2: the second major structural development was marked by the addition of a large brick lined flue to the chimney at the east of the puddling sheds. This flue was in turn probably linked to an apparently very early regenerative puddling furnace which vented into the pre-existing chimney. A second regenerative furnace immediately south of the first was also uncovered and exposed during the watching brief.
- Phase 3: was marked by the addition of a large chimney base between the two pre-existing chimneys. This change was associated with the installation of a series of small bottle-shaped puddling furnaces which were linked by brick surfaces, drains, pre-heat / heat exchange systems and flues. An additional boiler was also linked to the pre-existing and additional chimneys. This phase was associated with the addition of a large steam hammer which was erected to the south side of the building. This may explain a large extension to the south side of the southern puddling shed shown on the 1888 OS map. This plan coincides well with the detailed description of the puddling process at Monk Bridge, published in 1887 (Kinchin-Smith, 2004, Appendix 1). Apart from the removal of the steam hammer, the sheds the appear to have been unaltered until the time of the 1923 factory plans which show in detail the interior of the sheds.
- Phase 4: a number of features associated with a large new block which was erected on the site of the puddling sheds from 1957 to 1965. (Kinchin-Smith,

2004, RPS Buildings H, H1 and H2 – **Illustration 3**) were noted during the excavations, many of them truncating earlier features.

Phase 1: Large Sandstone Foundations and Chimneys I & III

The natural soil 4188=4187 uncovered on this part of the Site was a light yellowish grey sandy clay which was fairly level across the area of the trench. The level of the natural was marginally lower than the level of the bank of the Leeds to Liverpool Canal situated to the immediate east. This may imply that there may have been a degree of levelling of the Site either prior to the construction of the works or as part of the work's construction.

The earliest features on Site were four substantial sandstone wall foundations, numbered 1 to 4, with red handmade brick upper walling bonded by a white lime mortar with charcoal inclusions (**Illustration 16** and **Plate 18**) (NB: walls 1 and 2 had been truncated at their western extents). The wall foundations 3 and 4 measured some 9.5m long x 0.5m wide x 1.9m in depth and essentially formed two parallel foundations with a gap between them of 3.5 metres. These walls coincide with the known positions of the north wall of the south range of puddling sheds and the south wall of the north range of puddling sheds.

Linking the pairs of the walls were the foundations of two large chimney stacks (**I and III – Illustration 16 and Plate 19**), each consisting of a large stepped foundations of sandstone (I: 4419 between walls 1 and 2; III: 4067=4068 between walls 3 and 4). These measured around 3.5m square at the base and both went to a depth of c. 1.7 metres below ground level (**Plate 20**). On the top of each chimney foundation were rectangular brick chimney floors (I: 4150; III: 4072, 4073, 4074). Exhaust entry into the chimney must have been above ground level as no evidence for entry flues was noted.

Between walls 3 and 4, just to the west of chimney III, walls 3 and 4 were also connected by two transverse sandstone foundations, which were connected in turn by a pair of longitudinal sandstone foundations (**Illustration 16 and Plate 18**). The voids between the foundations were backfilled as part of the first phase made ground. The backfill was then overlaid by a flat brick floor 4373. The upper surfaces of the sandstone foundations, around the brick floor and the floor itself, showed considerable heat damage and discolouring suggesting that whatever structure was located here may have housed some form of furnace or a heat-exchanger that may have been connected above ground to the chimney to its east. No evidence of a similar furnace was evident between walls 1 and 2, although the western portion of these walls had been heavily truncated later by a massive concrete ramp and wall structure 4021-4023 and 4105-4116 (see Phase 4 below) just to the west of chimney I.

Following the construction of the first phase foundations the ground level was raised by some 1.8m in height, presumably to create a uniform floor level. These deposits were 4288–4492 at the west end of the Site. Similar deposits of 4431–4435, 4449 and 4436–4444, were between the west and east paired walls and chimneys I and II. Deposits 4066, 4183–4186, 4190 and 4448 were situated at the eastern end of the excavated area, whilst deposits 4397 and 4423 were located at the area's southern end. These deposits were primarily made up of industrial waste or clinker, clays and crushed brick rubble.

No evidence of early or primary (Phase 1) puddling furnaces was found within Trench D, all evidence having been removed by later puddling furnaces and associated features. Some fragmentary evidence of earlier puddling furnaces may have been noted during the strip and record exercise, notably within the footprint of a pre-1888

northern extension to the northern puddling shed (Area 2a, to the north of Trench D). Further work will be required to properly identify and phase these.

Phase 2: Gas Regenerative Furnaces and Brick Flues

The second phase of activity was concerned with the construction of a new type of furnace and the addition of new underground flues leading to the existing chimneys (I and III) (**Illustration 16**). Apart from the use of hand-made brick there was little direct dating evidence. It is unclear at this point to which historic map stage this belongs, however, we tentatively suggest this phase may correspond to an experimental puddling phase after ownership had passed to Kitson in 1854.

At the eastern end of the Site, the first phase made ground 4448 was truncated by a construction cut 4353 for two brick flues (Culvert North: 4069, 4335, 4336 and Culvert South 4070, 4177, 4176, 4174) (**Illustration 16**) which were keyed into the earlier chimney III by a sloping floor surface 4071 (**Plate 21**). Both flues ran at around 90°, sloping down, to the north east and south east respectively. The better preserved southern flue ran for some 3.5m at this angle before dog-legging to the south for some 1.9m terminating at the brick surface of a cellar 4173 and an iron door which lead into the lower eastern wall 4239 of a probable flue cellar 4270, 4239 (**Illustration 16**). Unfortunately some key relationships between the flue and the Alpha regenerative furnace (see below) had been destroyed by the insertion of a modern rectangular building 4241 (**Illustration 16**).

The furnace remains from this phase were amongst the most interesting and potentially important archaeological features noted during the excavations. The remains consisted of at least six small, below-ground, regenerative chambers, separated into two groups (Alpha and Beta) by a substantial later cut pipe trench. All six chambers had been truncated by a later post-war concrete and brick feature 4241 at their eastern ends.

The northern group (**Alpha**) consisted of two vaulted firebrick chambers of differing widths, interpreted as gas and air chambers 4153, 4269, 4301, 4060 (**Plate 22**). Both were filled with highly vitrified fire bricks (measuring 0.22m by 0.13m by 0.08m) laid in a chequerboard layout 4181, 4180, 4302. Let into the arched roofs 4152, 4271 were inlet/outlet flues 4271, both also highly vitrified, with metal slag deposits that would benefit from detailed analysis (**Plate 23** and **Section 6.5**). The eastern truncating feature was removed during a subsequent watching brief. This showed that there had been further chambers to the north (**Plate 22**). The vaults of these had been truncated by the base of a later bottle-shaped puddling furnace (**F**). Unlike the Beta group (see below), there was no sign of an access cellar at the west end of the group. Walls 4270 and 4239 noted at the east end of puddling furnace F appeared to be the northern and eastern walls of a possible access / flue cellar, as discussed in trenches B1 and B3.

Some 2m to the south of the Alpha group was another similar group (**Beta** – **Plate 24**), which consisted of four regenerative chambers 6045, 6047, 6049, 6051 and 6053. Its two gas and two air chambers were identical to the single examples noted in the Alpha group. All had chequerboard brick interiors 6046, 6048, 6050 and 6052, arched roofs 4124, 4133 and 4267 and inlet / outlet flues 4134 and 4145 rising from the crowns of the arches to surface. Whilst it is uncertain whether there was a cellar at the east end, there clearly was an in-filled, formerly arched-roofed cellar 4126, 4384 and 4375 associated with these chambers abutting their western ends. This cellar contained bricked-up access arches (**Plate 25**), as noted in the regenerative furnace noted in Trench B3.

Between the two areas of below-ground regenerative chambers and to the west of the cellar were the remnants of brick flooring 4252, 4253, 4396 and 4409. This fragmentary floor was laid on an associated clinker made ground layer. Both were subsequently heavily truncated by the insertion of the foundations and anvil support of a large steam hammer (see phase 3) and also by later drainage. Also located nearby was the foundation of a column support 4405 and 4406 which had subsequently been enlarged 4247, 4248 and 4249. This latter feature has the potential to assist in reconciling above-ground documentary sources (notably the historic painting and photos) with the building's excavated internal plan.

Notes on the Gas Regenerative Furnaces

The particular interest of these below-ground regenerative chambers stems from their small size and apparent early date (possibly c.1860s). Frederick Siemens first patented the design in 1856 (patent number 2861) and a number of developments over the next eight years lead to the (Siemens – Martin) process to be used for the direct manufacture of cheap bulk steel from cast and scrap iron and iron ore.

There are three possible hypotheses to explain the presence of the regenerators within the Monk Bridge puddling sheds:

- The first hypothesis is that the Alpha and Beta groups represent the bases of a pair of Siemens gas puddling furnaces as a refinement of the Cort puddling process.
- The second possibility is that the furnaces were used for welding small pieces of puddled iron into much larger ingots prior to rolling (Kinchin-Smith, 2004, Appendices 1 and 2). Conundrums regarding the precise location of this process within the work's may be resolved as part of further reporting.
- The third potential hypothesis is that the regenerators are the below-ground remains of two small and potentially early, Siemens Martin steel-making open hearth furnaces.

The resolution of these hypotheses may be resolved as part of further work.

Phase 3: Puddling Furnace Bases, Chimney II, Boiler Bases, railway lines and Steam Hammer Base

Phase 3 was dominated by a major re-working of the entire puddling shed operation. This appears to have included all-new puddling furnaces and associated waste heat boilers, new drains, additional chimneys, the insertion or reworking of a rail line at the east of the puddling sheds and the installation of a steam hammer, whose base was inserted through the earlier brick floors to the west of the gas regenerators (**Illustration 17, Plate 19**). This re-working of the building may have taken place over more than one sub-phase. The addition of the rail line coincided with a lengthening of the puddling sheds to the east. This had certainly taken place by the time of the Great Northern Railway 1882 session map (Kinchin-Smith, 2004, Fig 10), whilst the additional chimneys (and by implication the contemporary economisers) had clearly been added by the time of the survey for the far more detailed and reliable OS 1:500 map, surveyed 1888-90. This work appears to have been contemporaneous with the widening of most of the northern puddling range and the partial widening of the southern range, the latter extension appearing to have been specifically associated with the addition of a large steam hammer. The plant and structures appear to have then remained little altered, the c.1888 plan and the 1923 factory plan showing few, if any, salient differences with each other, or with the undated photograph of the

interior of the northern puddling range (Fitzgerald, 2004, Fig 25). These later sources appear to illustrate the layout and working practices vividly described in the written accounts of the forge's operations, dated 1887 and c.1900-1905 (Kinchin-Smith, 2004, Appendices 1 and 2).

The excavation revealed two parallel rows of three east-west orientated bottle-shaped structures of fire brick, located to the north and south of the existing chimney bases (I and III) (**Illustration 17, Plates 19** and **26**). In plan and location these exactly matched six of ten ostensibly identical structures marked on the 1923 factory plan and revealed as puddling furnaces in the undated photograph of the puddling sheds (Fitzgereald, 2004, Fig 25). The subsequent strip and record exercise in the area to the north (Area 2a – **Illustration 18**) uncovered remains of an earlier east–west alignment of puddling furnace bases 6161, which were clearly truncated and overlain by two further pairs of similar 'bottle-shaped' puddling furnace bases evident on the 1923 factory plan and clearly implied on by the 1888-90 1:500 O.S. map (**Illustration 15**). The complete absence of any traces of similar earlier Phase I or Phase II puddling furnaces within Trench D suggests that the 'bottle-shaped' puddling furnaces and associated economisers, chimneys and new steam hammer represented a very thorough re-equipment of the entire puddling operation.

The excavated chimney base 4310, 4041, 4095-9 (see **(II)** on **Illustration 17, Plates 19** and **27**) comprised a squared brick raft supported on a substantial slabbed sandstone and underlying concrete foundation. This was inserted in between the two earlier chimneys (I and III) and between the earlier foundations of the north and south ranges (walls 3 and 4). Between this chimney and Chimney III was an inserted 5.75m x 5m squared red brick foundation with angled corners 4037, 4038, 4057, 4093 and 4088 divided into three cells by two contemporary north–south orientated cross-walls on sandstone foundations 4087 and 4089 (**Plate 18**). This squared feature corresponds exactly with a paired feature shown on the c.1888 plan, the 1923 factory plan and the undated photograph of the interior on the northern puddling range (Fitzgerald, 2004, Fig 25). From the photograph it is clear that the paired features represent a pair of stout, large diameter boilers and the squared feature and cross-walls represent their supporting structure. Their position in relation to the two rows of puddling furnace bases and chimneys indicates these boilers utilised the waste heat from the puddling furnaces. The excavated boiler base correspond with one of six similar paired boilers shown on the 1888-90 1:500 OS plan and to one of five (plus one single) paired boilers shown surviving in 1923. Pottery fragments recovered from deposits connected with the boiler support features 4039, 4233 and 4236 (**Section 6.2, Appendix 3** - **Tables 8** and **9**) all fall within the mid-late 19th-century date range. The foundations of the boiler bases were structurally integrated with the side walls of 'bottle-shaped' puddling furnace bases C–F, chimney II and into the relative connecting surfaces, confirming that all of these features related to a single campaign of construction.

The puddling furnace bases themselves (here identified A to F on **Illustration 17, plates 19** and **26**) (see **Appendix 1** for context list for individual numbers) were arranged in two parallel east-west rows located immediately north and south of the chimney and boiler foundations. Puddling furnace bases A, C and E were located to the north of the chimneys, within the northerly puddling shed, whilst B, D and F were located south of the chimneys, within the southern puddling shed. Each row was partially built over the footings of the former north wall of the south puddling shed and the south wall of the northern range (foundations 1 to 4). If these sides of the two ranges had formerly been walled, these walls had clearly been made open-sided

before, or during, the reworking.

Each puddling furnace base in the northern range was represented by truncated brick walls describing an area around 4m long x 1.9m wide and narrowing at one end, with a brick floor within (**Plate 28**). Furnace bases C and E were arranged as an opposing pair, linked by with a narrower connecting 'neck' comprising a slightly higher area of flat (truncated) solid brickwork 4034, 4035 and 4063 measuring some 3.8m long x 1.3m wide. This narrower area appears to have represented the two 'necks' of the opposing 'bottle-shaped' puddling furnaces (**Plate 26**). One of the puddling furnace bases (D) retained embedded remains of vertical metal anchorage bars 4052 on its southern edge. The narrowing of the Monk Bridge puddling furnaces at their necks is clearly shown on the 1923 factory plan (**Illustration 17**) and in the undated photograph of the interior on the northern puddling range (Fitzgerald, 2004, Fig 25). The 'neck' clearly represented the exhaust end of each puddling furnace, probably feeding directly into the adjacent waste heat boiler. Each of the puddling furnace bases retained melted metal / slag deposits 4324, 4306, 4192 and 4156 towards their 'neck' (exhaust) ends. These deposits were sampled and will require micro-structural and chemical characterization (see **Section 6.5**).

The three corresponding puddling furnaces within the southern puddling range (bases B, D and F) were identical in layout and detail with their northern counterparts in all salient respects.

All of the puddling furnace bases had evidence of what appeared to be drainage at their flat (firebox) ends (**Illustration 17**). A brick sized void in the in the rear walls of the puddling furnace bases B and D linked to a small manhole which contained a drilled iron plate (each hole = 0.01m diameter) which in turn covered a 0.14m diameter ceramic pipe 4366 – 4371. These ceramic pipes then lead to a larger apparent drain which was in turn linked to a large square manhole 4417/4101 (**#** on **Plate 19**). The manhole was in turn connected to apparent south sloping drainage at the rear ends of puddling furnace bases A and C 4226, 4228, 4225 and 4228. The drains continued further to the south where they were subsequently truncated by a substantial late drain 4148 which bisected the trench from east to west. Pottery from this cut 4144 and 4165 (**Section 6.2, Appendix 3 - Tables 8** and **9**) falls within the 19th-century date range, possibly suggesting that this drain precedes the Doncasters rebuild of the 1950s.

To the south of the extended Trench D the base of a large steam hammer was excavated (**Illustration 17**). This consisted of two large foundation blocks 4256, 4395, 4257, 4258 and 4387, 4390, 4391 set to the east and west of a sandstone-lined anvil pit 4386, 4388, the latter containing percussion-dampening timbers 4394 within. The insertion of this substantial hammer appears to have truncated the brick flooring of phase 2. As stated above, its position coincides with a southern extension to the southern puddling sheds that is first evident on the 1:500 OS map, surveyed 1888-90 (**Illustration 15**). The hammer's location within the puddling shed (some 2.5m away from the puddling furnaces) suggests its use as a 'shingling' hammer used within the puddling process.[1]

Phase 4: Scrap Yard and Modern Buildings (1930 onwards)

The historic map regression shows that the puddling sheds were demolished sometime between 1932-3 and 1944, the latter map showing the area occupied by two

[1] 'Shingling' is the hammering of an iron bloom whilst in a plastic state to force out slag and impurities, and to consolidate the metal into a block.

additional railway sidings and a 'Scrap Yard'. The area was then radically reworked after the Doncasters company took over the Site in 1951, the area being redeveloped as RPS Building H1, H1.1 and H1.2 (**Illustration 3**), built in three phases between 1957 and 1964.

A number of modern structures were uncovered within Trench D. Two concrete wall foundations 4025, 4050 and wall 4076, 4094, 4077 uncovered (**Illustration 17**) within the footprint of RPS Building H do not seem to relate to walls of the standing building. Jessop and Douglas, forthcoming) indicate that this building was constructed in three separate phases. The exact positioning of the archaeological remains within this building sequence may be resolvable within a full detailed report. These remains are outlined below.

A modern complex of rectangular raised floors and ramp set within a concrete surround 4021-4023, 4105-4116 were located at the western end of the trench (**Illustration 17, Plate 29**) and a series of modern rectangular walled troughs 4135-4141 were located at the eastern end of the trench. Massive below-ground remains were evident across the northern edge of the excavated area 4198 and east of the trench 4357 with less substantial features 4260, 4125, 4028 across the south of the trench.

5.4.3 Strip and Record Areas 1a and 2a

The strip and record exercise was carried out in Areas 1a and 2a to the south and north of Trench D respectively. Additional material was also uncovered in the watching brief prior to its abandonment on health and safety grounds.

To the north of Trench D (Strip and Record Area 2a) good preservation of archaeological remains was uncovered. At least two phases of puddling furnace bases were identified. The earliest 6165 and 6161 were orientated east-west and quite clearly truncated by two pairs of puddling furnace bases 6151, 6152 and 6158, 6159 and a single puddling furnace base 6163 to the east of these (**Illustration 18, Plates 30** and **31**). These structures would appear to fit within the northernmost of the twin range sheds from at least as early as the 1888 O.S. map and the later additions appear to be shown as extant as late as the 1923 factory plan. Another structure of note was a partially revealed red brick feature measuring at least 2.65m long by 5m wide by at least 1m deep 6160. The structure was divided into three squared segments (**Illustration 18, Plate 32**) and appears to tie in with the location of paired parallel rectangles shown on the 1888 O.S. map of the site. The exact positioning of the archaeological remains within this building sequence may be resolvable within a full detailed report.

To the south of Trench D (Strip and Record Area 1a) two large sandstone structures with threaded iron pins 6007/6008/6009 and 6013 were uncovered. Their location corresponds with two squares located on the 1923 factory plan (**Illustration 18**) within the extention of the southern puddling shed evident by the 1888 O.S. map of the site.

The watching brief prior to the main ground remediation uncovered two structures of note. First, the removal of the modern obstruction 4241 (see **Illustration 17**) allowed an opportunity to examine both Alpha and Beta regenerative furnaces in section (**Plates 22** and **24**). Second, a large flue 6058 and chimney 6059 were uncovered immediately west of the Alpha regenerative furnace (**Illustration 19, Plate 33**). The flue 6058 walls were constructed from red hand made bricks measuring 0.24m by 0.11m by 0.08m and was capped by large (1.2m) squared iron

plates. The flue measured over 5m in length by 1.2m wide by at least 0.5m deep. The flue was aligned north to south, curving slightly to the east, and was truncated at its northern extent, where it was rising in inclination, by the Phase 3 puddling furnace bases D and F. The southern end was keyed into a squared brick (with the same measurements and type as the flue) chimney 6059 (**Plate 33**). The chimney was truncated by the cellar 4126, 4384, 4375 relating to the Beta regenerative furnace suggesting that these structures related to the early Witham puddling operation. The exact phase positioning may be resolvable within a full detailed report.

5.4.4 Assessment of the Puddling Sheds Area

The puddling sheds area, represented by Trench D and Strip and Record Areas 1a and 2a, is of interest because of its very good below-ground preservation and because it incorporates the first phase puddling sheds built for Stephen Witham in 1851. Unfortunately the puddling sheds (including extensions) were built too early to warrant the deposition of detailed building plans. However, there are a number of documentary and visual evidence which can be used to clarify and interrogate the archaeological data. These include some deposited building plans, various large scale area plans, site specific historic descriptive texts, the 1854 Witham painting and historic photographs (Fitzgerald, 2004) as well as information recorded during the standing building survey (Jessop and Douglas, forthcoming). There are also many historic and recent academic and technical descriptions of processes involved in iron production processes which can be utilized as part of further work. There would be considerable scope and value in further analysis of a number of features, most notably the puddling furnaces and the regenerative chambers and cellarage, particularly with regard to detailed descriptions, drawings (plans and elevations) and metallurgical analysis.

There would appear to be no merit in carrying out further work regarding the post-Second World War Doncasters period as the later below-ground remains were sparse, largely un-diagnostic and appear not to add anything to what we already know from other sources.

6 SUMMARY OF THE ARTEFACT ASSESSMENT

Assemblages of animal bone, ceramics, clay tobacco pipes, glass, metal and metallurgical materials were recovered from the excavation. This material is assessed below.

The recommendations of the specialists are outlined in **Section 8.2** below.

6.1 **Animal Bone** (Dr. Kim Vickers)

The current assemblage derives from four contexts; two trough fills, one made ground deposit and a deposit within a building. The following constitutes an assessment of the material and recommendations considering the assemblage's potential and future analysis.

6.1.1 Method

The method used in the assessment of bones follows a modified version of that outlined by Davis (1992) and Albarella and Davis (1994). Briefly, the elements included as 'countable' are: loose upper and lower teeth (in mammals); jaws with at least one tooth in place; cranium (complete or partial zygomaticus); atlas; axis; scapula (glenoid cavity); coracoid (in birds); distal humerus (at least half), distal radius (at least half), proximal ulna, carpal 3 (C3), distal metacarpal (at least half), carpometacarpus (in

birds), pelvis (ischial part of the acetabulum); distal tibia (at least half); calcaneum; scaphocuboid; distal metatarsal (at least half); phalanges 1, 2, and 3. Wherever possible fragmented bones with clearly matching edges were reconstructed. Countable fragments were identified to species or species group using the reference collection at the Department of Archaeology, University of Sheffield.

In addition to these 'countable' elements, other 'non-countable' specimens were recorded. These include horncore, antler, bones with evidence of butchery or bone working, and ribs and vertebrae (recorded as belonging to a small, medium or large sized animal). The preservation state of material from each context was noted and the number of measurable elements and ageable mandibles are also recorded.

6.1.2 Discussion

The assemblage was well preserved, and only one bone fragment showed evidence of rodent gnawing. Six bone fragments exhibited green discolouration, probably as a result of contact with copper during burial.

Table 1 (below) summarises the number of fragments for each species for each context. The assemblage was very small. Only one countable element, a rabbit (Oryctolagus cuniculus) femur, was recovered from the assemblage. This was also the only measurable bone. Rabbit remains may represent the bones of an animal eaten at or near the Site or they may be intrusive. The remaining 10 fragments were made up of medium mammal sized rib fragments (8) and non-countable long bone fragments (2). There were no age-able mandibles present.

There was some evidence of butchery, four of the rib fragments had been sawn across the shaft.

Context	*Oryctolagus cuniculus*	Bird	Medium Mammal	Total
1021		(1)		(1)
1023			(8)	(8)
4039	1			1
4227				0
TOTAL	1	(1)	(8)	1 (9)

Table 1: *Summary of the faunal elements (non-countable bones are given in brackets).*

6.1.3 Recommendations

See **Section 8.2.4** below.

6.2 **Ceramics** (Dr. C. G. Cumberpatch)

The pottery assemblage consisted of 81 sherds of pottery weighing 2381 grams and represented a maximum of 66 vessels. The data are summarised in **Table 8** (**Appendix 3**). Ceramic building material and other items are listed in **Table 9** (**Appendix 3**).

6.2.1 Discussion

The earliest pottery from the Site was of 18th century date and consisted of sherds of Mottled ware and Late Blackware. These were few in number and the greater part of the assemblage was of mid to later 19th-century date with a small number of sherds of later 19th and early 20th -century date. The latest sherd to be positively identified was

the coronation commemorative mug from context 4159 which dates to 1937. This would seem to be consistent with the history of activity on the Site summarised in the assessment report (Dransfield, McCoy & Davies, 2006) with the 18th-century pottery forming a residual element within the assemblage. This may have been derived from earlier activity on the Site but equally it is possible that some material was brought to the Site in connection with building operations. This has been demonstrated to have occurred on industrial sites in Sheffield, but has yet to be proved for Leeds where building practices may have been different and where the local topography may not have required it.

6.2.2 Recommendations

See **Section 8.2.1** below.

6.3 **Clay Pipe** (Dr. P. Marshall)

A total of 13 clay pipe fragments were recovered during excavation, as summarised in **Table 2** below.

Site Code	Context	Quantity	Description
971b	4183	2	stem fragments
971b	4381	2	stem fragments
971b	4252	2	stem fragments
971b	4169	2	stem fragments
971b	4313	1	stem fragment
971b	2632	1	stem fragment
971b	4315	1	stem fragment
971b	4232	1	stem fragment
971b	1046	1	stem fragment

6.3.1 Discussion

It is notoriously difficult to accurately date clay pipe stems. This assemblage can be attributed generally to a 19th/20th-century date.

One clay pipe fragment was recovered from the second made ground episode 1046 in Trench A. The stem fragment is un-diagnostic typologically and un-dateable.

One stem was recovered in Trench B3 was from made ground surrounding a drain 2632. The stem fragment is un-diagnostic and un-dateable.

The rest of the clay pipe fragments came from a variety of contexts in Trench D. These deposits included made ground episodes, pipe cuts and the backfill within a cellar and the boiler base. The stem fragments are un-diagnostic typologically and un-dateable.

6.3.2 Recommendations

See **Section 8.2.5** below.

6.4 **Glass** (Dr. P. Marshall)

A total of 53 glass fragments were recovered during the excavation, from 17 stratified contexts. These are summarised in **Table 3** below.

Site Code	Context	Quantity	Description
971b	1018	1	1 sherd no detail
971b	1021	2	2 bottle base fragments from same vessel (wine bottle)
971b	1023	5	green vessel sherds (wine bottle)
971b	1046	3	3 glass sherds
971b	1070	3	green bottle sherds, inscription on bottle (partial) reads "brewst... b&d kirkstall"
971b	1071	4	2 miscellaneous fragments, 2 base fragments from same bottle (beer Tadcaster, probably *John Smiths*)
971b	1073	1	some indecipherable embossing
971b	1073	4	3 aqua vessel body sherds, 1 aqua bottle top with *'in situ'* wooded screw thread stopper
971b	1073	2	clear/aqua vessel (bottle neck) sherds
971b	1093	1	135mm high clear bottle, complete (medicine)
971b	1107	4	clear/aqua vessel sherds. Partial embossing on one reeds '...LEE...WERY...'
971b	1107	1	clear vessel fragments
971b	2033	1	green vessel sherd
971b	2034	5	3 sherds green tinted, 2 sherds clear
971b	2584	4	4 base sherds with patterning (cut)
971b	2632	2	clear flat sherd, 1 poss. mirror sherd
971b	4139	1	broken (length 145mm) glass pipe/tube, diameter 14mm
971b	4379	1	clear vessel sherd with white covering
971b	4381	3	three green vessel sherds (different vessels)
971b	Un-stratified	5	Fragments of light-bulbs

6.4.1 Discussion

The glass assemblage recovered from Trench A (1073, 1093 and 1107) was recovered from the primary and secondary deposits within the brick celled structures, as well as made ground. The assemblage is all machine made of an early 20th-century date.

The glass assemblage recovered from Trench B1 (2033 and 2034) was recovered from made ground clinker and the fill of a firebrick structure interpreted as a gas regenerative furnace. The assemblage is all machine made and early 20th-century in date.

The glass assemblage recovered from Trench B3 (2584 and 2632) was recovered from the backfill of another gas regenerative furnace and the backfill of a drain cut.

The assemblage is all machine made and early 20th-century in date.

The glass assemblage recovered from Trench D (4139, 4379 and 4381) was recovered from un-stratified surface layers and backfill of furnaces. The assemblage is all machine made and early 20th-century in date.

6.4.2 Recommendations

See **Section 8.2.6** below.

6.5 Archaeometallurgical Residues (Dr. R. Mackenzie)

6.5.1 Introduction

The aims of this assessment are to determine if any of the artefacts are of archaeometallurgical significance, and whether further scientific analysis could provide additional information about the artefacts, or specific aspects of the Site and processes carried out there. A summary of the material assessed is listed below in **Table 4**. Some of the dimensions of artefacts are given in imperial units, as these are more relevant, given the likely age of the artefacts. For completeness, the overall dimensions of the objects are shown in metric units.

Context no.	Material type	Description
1023	Ferrous metal	5 small concretions of friable iron oxide (rust)
1073	Ferrous metal	Length of corroded ferrous metal wire (150x5mm)
1097	Ferrous metal	Rivet (approx 130mm long)
1097	Ferrous metal	Possible off-cut of ferrous metal strip (approx 60x10mm)
1097	Ferrous metal	Length of corroded ferrous metal rod (approx 350x10mm)
1097	Non-Ferrous metal	Possible off-cut of copper sheet (approx 120x50x1mm)
1097	Ferrous metal	Rectangular plate, possible machine fitting/securing plate (approx 145x50mm)
1097	Ferrous metal	Very heavily corroded broken file blade (approx 110x25x10mm)
1097	Ferrous metal	Very heavily corroded broken file blade (approx 230x30x5mm)
1097	Ferrous metal	Heavily corroded strip of ferrous metal, probable off-cut of rolled or forged strip (approx 85x35x5mm)
1097	Ferrous metal	Heavily corroded strip of ferrous metal, probable off-cut of rolled or forged strip (approx 90x40x4mm)
1097	Ferrous metal	Heavily corroded strip of ferrous metal, probable off-cut of rolled or forged strip (approx 85x40x4mm)
1097	Ferrous metal	Heavily corroded 4 inch (100mm) bolt
1107	Ferrous metal	Corroded ferrous metal bar (overall dimensions approx. 415x45x40mm, 16x1¾x1½ inch), possible off-cut from a length of forged or rolled bar.**
1107	Ferrous metal	Corroded ferrous metal bar (overall dimensions approx. 220x22x22mm, 8½x⅞x⅞ inch), possible off-cut from a length of forged or rolled bar.**
1107	Ferrous metal	Fragment of heavily corroded sheet metal (approx 315x120x4mm)

Context no.	Material type	Description
1107	Ferrous metal	Length of heavily corroded ferrous metal rod (approx 280x15mm)
1107	Ferrous metal	Length of very heavily corroded bar or rod (approx 220mm long)
1107	Ferrous metal	8 inch rivet (approx 200mm)
1107	Ferrous metal	Very heavily corroded ferrous metal strip (approx 170x50mm)
1107	Ferrous metal	Very heavily corroded ferrous metal strip (approx 60x50mm)
2589	Ferrous metal	Large cast iron weight, cylindrical with small handle on top (140x90mm)**
2618	Ferrous metal	Heavily corroded fragment of broken file (approx 180mm long)
2618	Ferrous metal	2 fragments of drainpipe fitting
2618	Ferrous metal	Corroded nut and bolt (approx 95mm long)
2619	Ferrous metal	Small cast iron weight, cylindrical with small handle on top (40x15mm)**
4039	Ferrous metal	Corroded ferrous metal bar (overall dimensions approx. 675x60x12mm, 27x2⅜x½ inch), possible off-cut from a length of forged or rolled bar.**
4039	Ferrous metal	Corroded ferrous metal bar, (overall dimensions approx. 240x68x25mm, 9¾x2¾x1 inch), possible off-cut from a length of forged or rolled bar.**
4039	Ferrous meta	Broken lathe/milling machine tool (approx 110x25mm)
4039	Ferrous metal	2 washers (approx 40mm diameter)
4039	Non-Ferrous metal	2 small off-cuts of (possibly) nickel silver
4039	Ferrous metal	4 short off-cuts of steel rod (approx 40x8mm)
4165	Ferrous metal	Large metal hook (approx 300x110mm)
4165	Ferrous metal	Off-cut of stainless steel (approx 100x30mm)
4165	Ferrous metal	2 small triangular off-cuts of stainless steel
4165	Ferrous metal	Ferrous metal disc or cap (approx 70mm diameter)
4426	Ferrous metal	Length of corroded ferrous metal tube with threaded end, which has a nut screwed on. Possibly a machine or structural fitting (approx 390x25mm)
4426	Ferrous metal	One piece of very heavily corroded ferrous metal strip embedded within iron oxide concretion (approx 120x25mm)
4426	Ferrous metal	2 corroded ferrous metal bolts (each approx 70mm long)
4263	Non-Ferrous metal	90mm length of multi stranded copper electrical cable.
4263	Ferrous metal	Off-cut of ferrous metal tube (approx 50mm long by 15mm diameter)
1022	Soil Sample 1	Soil sample, approx 5 litres in volume. Loose brown earth that may contain metalliferous residues

Context no.	Material type	Description
1017	Soil Sample 2	Soil sample, approx 5 litres in volume. Loose brown earth that may contain metalliferous residues
1019	Soil Sample 3	Soil sample, approx 5 litres in volume. Loose brown earth that may contain metalliferous residues
4061	Slag (sample 4)	Possible metalliferous slag**
4156	Slag (sample 5)	Possible metalliferous slag**
4180	Brick (sample 6)	Heat damaged refractory brick**
4180	Brick (sample 7)	Heat damaged refractory brick**
4180	Brick (sample 8)	Heat damaged refractory brick**
4152	Slag (sample 9)	Possible fuel ash slag
4148	Brick (sample 10)	Heat damaged refractory brick**
4148	Slag (sample 11)	Clinker
4134	Brick (sample 12)	Heat damaged refractory brick**
4134	Slag (sample 13)	Fuel ash slag/possible metalliferous slag**
4324	Slag (sample 14)	Metalliferous slag**
4036	Slag (sample 15)	Metalliferous slag**
4192	Slag (sample 16)	Metalliferous slag**
4090	Slag (sample 17)	Metalliferous slag**
4397	Slag (sample 18)	Undiagnostic slag
4411	Soil Sample 19	Soil sample, approx 1 litre in volume - may contain metalliferous residues
2581	Brick (sample 20)	Refractory brick with vitrified/slagged surface**
2582	Slag (sample 21)	Fuel ash slag
2583	Brick (sample 22)	Refractory brick with vitrified/slagged surface**
2613	Residue (sample 23)	Spot sample, approx 250ml volume. Lime rich clay
2603	Brick (sample 24)	Heat damaged refractory brick**
2598	Brick (sample 25)	Heat damaged refractory brick**
2598	Brick (sample 26)	Heat damaged refractory brick**
2599	Brick (sample 27)	Heat damaged refractory brick**
2599	Brick (sample 28)	Heat damaged refractory brick**
2600	Brick (sample 29)	Heat damaged refractory brick

Context no.	Material type	Description
2601	Brick (sample 30)	Heat damaged refractory brick
1120	Slag (sample 31)	Undiagnostic slag
Unstrat.	Slag (Sample 32)	Large fragment of tap slag, possibly from puddling furnace**

Table 4: *Assessment Summary of Metals, Refractories and Industrial Process Residues (**indicates where material should be retained as part of site archive and/or further analysis)*

6.5.2 Discussion

The assemblage contains a range of materials that is consistent with the former use of the Site. The assemblage can be separated into five categories of material, these are:

- Pieces of ferrous metal sheet, bars and strip.
- Metal structural/machine fittings and tools
- Slag
- Soil samples
- Refractory brick

Although the bulk of the assemblage is of limited archaeometallurgical potential, some pieces are very significant, and these are discussed below.

The pieces of metal bar found in contexts 1107 and 4039 are possibly made from puddled iron, and they appear to be off-cuts from forged and/or rolled bars. It is common practice in iron and steelworks for off-cuts of bars and strips to be collected as scrap for re-recycling, which explains why it is relatively unusual to find off-cuts of this type.

The scarcity of historic metals available for analysis means that there are comparatively few modern analyses of 18th-and 19th-century British iron and steel. Where the metals do exist, they are often incorporated into artefacts or structures of historic significance, and the removal of samples for metallurgical analysis is impossible. Perhaps surprisingly, there are more published analyses of iron and steel artefacts from the Romano-British period than there are from the British industrial revolution period of the 18th and 19th centuries.

Archaeometallurgically, this is an interesting site, as it was one of a handful of works that made 'Best Yorkshire' iron. 'Best Yorkshire' iron set the quality standard for wrought iron in the UK (Shelton *et al* 2002). There is a paucity of published archaeometallurgical analyses of British puddled iron, and only two (one partial) of 'Best Yorkshire' iron have been published.

Metallurgical analysis of historic metals can provide information on the type and quality of metal; the results can also form important reference data for determining the process origin of unprovenanced metals from other sites. If the pieces of iron recovered from the Site are found to be made from 'Best Yorkshire' wrought iron, they are potentially of International significance and results of their analysis should be published in a relevant journal.

The weights recovered from contexts 2589 and 2619 are, metallurgically, less significant. However, they may have been used for weighing up furnace charges and it would be interesting to know whether they are imperial or metric weights.

The metalliferous slags recovered from the contexts associated with the puddling

furnaces are archaeometallurgically significant, as it is relatively unusual to find historic slags directly associated with their production source. Analysis of slags where the production source is known can be very useful for working out the method used to produce wrought iron. 'The basic structure of wrought iron is independent of the process by which it was made, and is not diagnostic. However, slag inclusions, always present in wrought iron, may retain characteristics of the process by which the metal was made' (Gordon 1997, 13).

One of the potentially most interesting pieces of slag is the large piece of tap slag (sample 32). The context from which this piece was recovered contained numerous blocks of tap slag that possibly relate to the nearby puddling furnaces. Analysis of sample 32 will determine whether the slag was produced by the puddling furnaces. The composition of the slag can be also be compared to the slag inclusions within the off-cuts of iron bar to determine whether these were made from puddled iron produced at the Site.

Published analyses of 'bulk' slags from British puddling furnaces are extremely scarce and the results of analyses of the Monk Bridge furnace slags could provide important reference data of International significance.

Some of the refractory bricks from the gas regenerators appear to have possible metalliferous slag attached. Analysis of the slag will help to determine whether these slags are metalliferous and, if so, may suggest their likely production source.

Analysis of the refractory bricks from the gas regenerator structures is likely to confirm what is already known about the process. However, as the bricks are so symptomatic of gas regenerators, they should be retained as part of the site archive, against which material from other archaeological excavations can be compared.

6.5.3 Recommendations.

See **Section 8.2.2** below.

6.6 **Leather** (Dr. P. Marshall)

A total of 21 fragments of leather were recovered during excavation, as summarised in the **Table 5** below.

Site Code	Context	Quantity	Description
971b	1071	1	Belt fragment
971b	1107	19	Shoe fragments
971b	2619	1	Unidentifiable

6.6.1 Discussion

Two contexts from Trench A contained leather. The belt fragment was uncovered from the modern backfill of the brick celled structure 1071. The backfill of the construction cut for the large crane base 1107 contained nineteen pieces of shoe leather which were too fragmentary to allow further analysis. An unidentifiable piece of leather was recovered from the fill 2619 from Trench B3.

6.6.2 Recommendations

See **Section 8.2.7** below.

6.7 **Miscellaneous** (Dr. P. Marshall)

A total of 8 miscellaneous items were recovered during excavation, as summarised in the **Table 6** below.

Site Code	Context	Quantity	Description
971b	1023	2	coal
971b	4179	1	Players cigarette packet
971b	1097	1	Roof slate
971b	2585	1	Glove
971b	6096	1	Plastic socket
971b	2589	2	bottle tops

6.7.1 Discussion

In Trench A, two pieces of coal and a fragment of roof slate were recovered from the backfill of the brick celled feature. Within Trench B3 a leather glove was recovered from the backfill of the furnace and two bottle tops were recovered from modern made ground. In Trench D, the backfill of the Alpha furnace contained a Players cigarette packet which may be dateable to a specific period. The backfill of the Tyre Blocking Press contained a modern plastic socket.

6.7.2 Recommendations

See **Section 8.2.8** below.

6.8 **Metal Artefacts** (Dr. J. Unwin and Mr. K. Hawley)

The metal recovered from the excavations gave little that was indicative of the site's history. It would appear that all valuable metal (machines, scrap, etc.), had been removed. The list of identified finds is outlined in **Table 7** below.

From the history of the site, some evidence of steel manufacture, or at least evidence of machinery used in forging and casting might have been found. However, since this was latterly a highly specialised manufacturer which re-located to another production site, it is to be expected that all useful equipment would be removed. Also, any other metal would have been seen as scrap.

The identifiable finds seem to have come from heavy machinery, with a chain feed for a furnace 6172 and large pieces from unknown machines such as jib head keys 6091.

Other identifiable finds are finds are related to machinery, such as bolts 1097 and 2594 and other specific parts to unknown machines such as a piece of steam pipe 6096 and a section of a metal shaft (US = unstratified).

6.8.1 Recommendations

See **Section 8.2.9** below.

Site Code	Context	Notes
971b	1021	very large forged block, 6 inches by 4 inches by 4 inch, with a hollow possibly to take an 8 inch diameter section of something, as a housing.
971b	1023	engineers braid of woven strands for packing
971b	1073	unidentified

971b	1073	unidentified
971b	1097	5 inch x 5/8inch square headed bolt; 1 cotter pin; possibly a square headed bolt
971b	1097	brass plate marked 'no.2 fitting [shop]'
971b	2033	unidentified
971b	2034	unidentified
971b	2584	4 5/8inch square headed bolt
971b	2585	ferrous washer
971b	4165	2 3/4inch diameter disc with a small hole near one edge
971b	4165	2 pieces of stainless steel scrap
971b	4236	token or a tally
971b	4252	3 inch rod of stainless steel, 1/4 inch diameter
971b	6091	1 inch square section 'L' shaped metal, 2 of, possibly jib head keys with cotter slots, one with a cotter. Intended to hold two machine parts together
971b	6096	3/4 inch steam pipe connected to a 'T' section with sight glass and petcock for releasing water
971b	6172	multi-layer chain drive for chain grate stoker for automatically firing a boiler, c.1900
971b	US	10inch metal shaft, one end squared to 7/8 inch, 2inch pinion with teeth, shafting collar at the square end

Table 7: *Summary of the metals.*

6.9 Bricks

All brick structures were noted in the field. Brick type (red brick or fire brick) and dimensions were recorded. Additional identifying marks such as frog type, dottles and maker's marks were also identified. Information on mortar type and the condition of the brick was recorded. All information was collated and added to brick recording sheets. Stamped bricks were photographed with a 0.3m scale.

A basic typology is set out in the context check-list in **Appendix 1**.

6.9.1 Discussion

It is possible to distinguish broad dating on the basis of mortar type. Broad phasing may also be possible between frogged and unfrogged bricks, however this should be used as a rough guide as unfrogged and frogged bricks were used at the same time and have been found within the same walling, particularly in the period to which this site belongs. Maker's marks are the most accurate dating method and will give a good *terminus post quem* for the build date of the structures.

It may also be possible to tie in the data retrieved from the excavations to the Standing Building Recording undertaken on the Site.

6.9.2 Recommendations

See **Section 8.2.3** below.

7 CURATION AND CONSERVATION

7.1 Recipient Museum

After agreement with the client, the project archive will be deposited with Leeds Museum. An Accession Number will be allocated. The deposition of the archive will be

done in accordance with the requirements for such depositions as are currently in use by Leeds Museum. The project archive will be prepared by the project staff in accordance with the requirements specified in Management of Archaeological Projects (English Heritage, 1991), and in accordance with the Guideline for the Preparation of Excavation Archives for Long Term Storage (United Kingdom Institute of Conservation 1990).

8 STATEMENT OF POTENTIAL

8.1 Introduction

The excavations at the Monk Bridge Iron Works have revealed a large number of structures involved with the processing of metal and metal working.

A combination of results from the evaluation, excavation and strip and record exercise revealed a high degree of preservation across much of the former works. This level of preservation allowed the targeting of specific areas and features, in order to successfully characterize, identify and refine our knowledge of many of the processes, structures and chronological developments within the works.

This statement of potential outlines areas in which further work will aid the updated research aims and objectives identified in **Section 9** below. The recommendations here will be cross referenced with the updated tabled objectives in that section by means of an allocated number system (e.g. **A1, B3** etc.).

8.2 Specialist Recommendations

The artefactual specialist recommendations are set out below. Although all the specialist recommendations are set out here only the ceramic and brick assemblages along with archaeolmetallurgical residues are considered to be worth further detailed analysis.

8.2.1 Ceramics

The proposed further work should be incorporated into the final report on the entire assemblage:

- full description, quantification and discussion of the assemblage by ware type, vessel form and function using sherds numbers, sherd weight and estimated (maximum) number of vessels;
- identification and recording of decorative motifs and designs;
- selection of material for illustration (maximum of five sherds or vessels);
- discussion of the assemblage by context and phase, in collaboration with the site director and other specialists with particular reference to contexts identified by the site director as of particular significance for the interpretation of the Site.

It is anticipated that the results of the further work will refine the chronological sequences of Site (**B3**).

8.2.2 Archaeometallurgical Residues

The assemblage contains archaeometallurgically significant material, the analysis of which has the potential to increase the existing knowledge of materials from this period.

Further analysis should be performed on the archaeometallurgically significant materials from the Site. Although some materials do not warrant further analysis at this stage, they should be retained as part of the site archive.

The recommended actions to be taken are listed below in their order of priority.

- Perform microstructural and chemical characterisation of tap slag (sample 32) to determine whether it is puddling furnace tap slag. Slag samples 5, 15 and 17 from the puddling furnace 'flues' should be characterised in the same manner as sample 32.
- Perform metallographic and chemical characterisation of samples of bar iron recovered from contexts 1107 and 4039. Compare results of analysis to those of the slag samples to determine whether the bars are made from puddled iron.
- Perform microstructural and chemical characterisation of slag samples from the flues in the roofs of the 'gas regenerator' structures. Purpose should be to try and determine the source of the slag and how it relates to the 'regenerator' structures.
- It is recommended that the samples identified above are all analysed using a combination of Scanning Electron Microscope with Energy Dispersive Spectrometry (SEM-EDS) and, where necessary, bulk chemical analysis.
- SEM-EDS is a powerful analytical tool that is widely used for the study of archaeological/historical metals and slags.
- The weights recovered from contexts 2589 and 2619 should be cleaned and then weighed. The weights should be retained as part of the site archive.
- Bricks recovered from the 'regenerator' structures should be retained as reference material in the site archive.
- Soil samples 1, 2 and 3 will need to be processed by soil specialist if there are specific archaeological questions connected with the contexts of these samples. Any archaeometallurgical residues found within the soil samples should be examined by an archaeometallurgist.
- If analysis finds the slag and metal samples to relate to puddling, the results should be written up for publication in a relevant journal.

It is anticipated that the results will further an understanding of the processes that were undertaken on the Site and also confirm the former Monk Bridge Iron Work's role locally, nationally and internationally (**A3, A6, A7, A8, A9, C1** and **C3**).

8.2.3 Bricks

It is recommended that further work be undertaken on the brick assemblage. The stamped bricks, in particular, should provide good dating evidence and should be assessed by a brick specialist. This should be undertaken by a specialist in brick and CBM (**B3**).

It is anticipated that analysis will refine the chronological sequences on the Site and may provide useful correlations with the standing building survey (**B2**).

8.2.4 Animal Bone

The bone assemblage from the former Monk Bridge Iron Works is very small and has very little potential to provide archaeological information. Therefore no further work

is recommended on this assemblage.

8.2.5 Clay Pipe

The assemblage here is relatively small, un-dateable and un-diagnostic. It is recommended that no further work is required on this assemblage.

8.2.6 Glass

The assemblage is relatively small and of an early 20th-century date. Apart from providing the dating evidence that we have already secured from the assessment, there is little of significance within the assemblage. It is recommended that no further work is required on this assemblage.

8.2.7 Leather

The leather is of little diagnostic value, and further reporting or analysis is not recommended.

8.2.8 Miscellaneous Artefacts

This is a very small assemblage of miscellaneous finds. There is little of intrinsic interest in the coal, slate, glove, plastic and bottle tops from these fairly modern deposits. The Players cigarette packet could possibly be dated but it is recommended that accurate dating evidence could be acquired from other sources. It is recommended that no further work be carried out on this assemblage.

8.2.9 Metal Artefacts

There is little in this assemblage which can add to our understanding of this site. The retention of these items is not recommended for the archive and no further work is suggested for this assemblage.

8.3 Materials

- Well preserved structures, such as the bases of regenerative and puddling furnaces and the possible tyre blocking press uncovered across the complex can enhance our knowledge of the techniques employed in their construction (**A2, A3, A5, A6** and **A7**). With the aid of archaeometallurgical analysis and further research of the relevant academic journal material, the remains may also allow an opportunity to further examine detailed aspects of the industrial processes within the structures themselves (**A1, A2, A3, A4, A5, A8** and **A9**).
- Metallurgical analysis of historic metals can also provide information on the type and quality of metal (**A3, A6, A7, A8** and **A9**); the results can also form important reference data for determining the process origin of unprovenanced metals from other sites (**A5** and **A10**). If the pieces of iron recovered from the Site are found to be made from 'Best Yorkshire' wrought iron, they are potentially of international significance (**C2** and **C3**) and results of their analysis should be published in a relevant journal.
- Analysis of slags, where the production source is known, can be very useful for working out the method used to produce wrought iron. These slag inclusions, always present in wrought iron, may retain characteristics of the process by which the metal was made (**A3, A6, A7, A8** and **A9**).
- Although only a small selection of pottery was uncovered from the Site, further analysis of some of the sherds, where they were found within primary deposits such as construction cut backfills, may be helpful in pinpointing more

accurate dating for some of the on-site developments of the works (**B3**).

8.4 Documentation

The investigations have also greatly increased our knowledge of the chronological development of the works and its associated buildings and the organization of space within the buildings themselves. For example, our understanding of the puddling sheds has been corroborated with the aid of various documentary, pictorial and historical sources, including several historic maps and factory plans as well as photographs and a painting.

Combining the results of the excavations, the strip and record exercise and the many historical sources has already proved invaluable in assessing the chronological and spatial development of the Site. There is considerable scope for further research and anlaysis:

- A detailed study of the site's standing buildings was carried out prior to clearance. Buildings targeted for detailed recording were those for which surviving documentary sources were poor or non existent. These were generally those that pre-dated the first Deposited Building Plans in Leeds City Archives (i.e. pre 1878). Whilst some of these buildings were not subject to subsequent excavation, detailed measured and photographic surveys were made of RPS Building E1 / E1.1 of 1861 (the building whose footprint was stripped by Trenches A, B1 and B3 and Strip and Record Area 3) and RPS Buildings G1 and G1.1 which retained substantial structural remains of the former rolling mills recoded within Trench C and Strip and Record Areas 1b and 2b (**B2**).
- Leeds City Library has a substantial collection of small scale 19th-century city maps, published by independent cartographers (e.g. Massar, 1858, and Brierley, 1866). Whilst often unreliable with regard to detail and date, they are invaluable sources for the early period. From 1888-90 the Ordnance Survey editions become the most reliable cartographic sources. The 1:500 1888-90 survey is a particularly useful source. Photocopies of all relevant city maps and OS editions are held by RPS and ARCUS (**B1, B2, B4, C1** and **C2**).
- There are a number of securely dated, detailed and large-scale factory plans covering the period 1923 to c.2000 currently in store on behalf of the client BAM (formerly HBG). The plans will be deposited with Leeds City Archives in due course. These are exceptionally useful in showing the location (if not necessarily the function) of historic and subsequent plant and equipment. The 1923 plan is of particular use, not only as the earliest detailed plan, but because excavation has shown that in most areas the plant and machinery shown is that initially installed. Excavation has been exceptionally useful in establishing or confirming the relative date and function of the various items of plant and machinery shown (**A4, B1, B2, B4** and **C1**).
- Leeds City Archives contains a comprehensive run of Deposited Building Plans for the site, covering the years after 1878 to the mid 20th-century. With regard to the excavated areas, there are three applications dating 1879-1881 covering four ranges of the rolling mills (Fitzgerald, 2004, plates 17-21). These will add significantly to the information yielded during the building recording and by the excavation of Trench C and Strip and Record Areas 1b and 2b. Plans of the puddling sheds are more sparse, being limited to a plan 1881 detailing a double chimney for puddling furnaces 9 and 14 (Fitzgerald, 2004, plates 22 and 23).

These plans show the feint imprint of an unidentified plan showing a large iron-framed building and may repay further study (**A4, B1, B2, B4** and **C1**).

- A number of historic pictorial sources survive, notably the 'Witham' oil painting showing the puddling sheds and rolling mill in some detail. Fitzgerald also identifies and reproduces ground level views of the open hearth refineries and the puddling furnaces c.1890-1910 and an oblique aerial view of 1921 (Fitzgerald, 2004, plates 24, 25 and 34). These are exceptionally useful as iconographic material, both for illustrative purposes and to corroborate evidence from Deposited Building Plans and archaeological data. The view of the puddling furnaces is of use in the interpretation of the remains discovered in Trench D and Strip and Record Areas 1a and 2a, and the potential generation of 3D visualisations and block diagrams detailing the layout, evolution and development of the Site (**A4, B1, B2, B4, B5** and **C1**).
- Known published written descriptions of the operation of the plant are currently limited to those of 1887 (12 pages), c.1900-1905 (3 pages) and 1936 (1 page), all located in Leeds City Library. These descriptions would be of great use in interpreting the remains found in Trenches C and D and Strip and Record Areas 1a, 1b, 2a and 2c (**A4, A6** and **A7**).
- Study of published technical literature, both generic and site-specific, has been very limited to date. Further documentary research has the potential to significantly elucidate our understanding of the processes themselves and interpretation of the surviving machine and furnace bases within works (**A1, A2, A4, A5** and **B1**).
- Detailed metallurgical analysis of the gas regenerators linked to further research of the documentary sources may also resolve the location of the Kitson's very early experiments in steel production. The erection of a purpose-built steel works to the south of the Whitehall Road in 1864-5 conflicts with documentary references which suggest this experimentation possibly occurred in the puddling sheds (Trench D and Strip and Record Areas 1 and 2a) to the north of Whitehall Road (**A8, A9, A10, B1** and **C1**).

A more comprehensive integration of the documentary, archaeological and academic sources is recommended to refine our understanding of the processes and chronological development of the forge.

It is anticipated that potential value of the archaeological and documentary archives for increasing our understanding of the activities undertaken at the Site, and for contributing to knowledge of Leeds' industrial past, may also be further enhanced by comparative analysis with the results of excavations undertaken at contemporary metallurgical and engineering sites, particularly within in the Holbeck / Kirkstall area (**A1, A2, A3, A4, A5, A6, A7, B1, B4, B5 C1, C2** and **C3**).

8.5 Standing Building Survey

A detailed study of the site's standing buildings was carried out prior to clearance. The data from this survey was undertaken on a local (a grid created on site by the ARCUS survey team based on the standing buildings) grid. The archaeological data was undertaken based on the O.S. grid. A correlation of the data from both surveys will be undertaken by the ARCUS Geomatics department with close consultation of those involved in the projects to affirm the location of both the standing and archaeological structures. Initial preparatory attempts to overlay the data are encouraging, particularly within RPS Building E1. These overlays have been

undertaken on computer only and are not yet available for publication here.

It is anticipated that using a combination of the results from both phases of work will refine the chronological sequences on the Site as well as providing data to possibly create above and below ground sections through buildings (particularly RPS Building E1) and creating 3D cutaways (**B1** and **B2**).

8.6 Interpretation of Results

There is considerable scope to analyse the results of the excavation and standing building survey within its wider contextual setting (**C1, C2** and **C3**).

It is anticipated that documentary and historical research will be required to place the Site within its wider historical setting will be undertaken. This will require examination of all stored material pertaining to the Site held at Leeds City Archives, Leeds City Library, RPS and ARCUS. Further research using internet sources, the Sheffield University online archive and library and ARCUS's own extensive library collection.

ARCUS have also been involved in the excavation of a number of sites in the immediate Holbeck area of Leeds. Murrey and Wood's Round Foundry was also located in the Holbeck area and the excavations at Kirkstall Forge (a major producer of cast iron products and an early (1797) producer of wrought iron and wrought iron products) will provide a unique opportunity to examine the former Monk Bridge Iron Works in relation to these local sites.

It is anticipated that the archaeometallugical research will also contribute to our knowledge of the production of 'Best Yorkshire' iron and to examine the potential of understanding the former Monk Bridge Iron Works within a national and potentially international arena.

9 UPDATED RESEARCH AIMS AND OBJECTIVES

9.1 Introduction

The primary aims and objectives of further post-excavation analysis and reporting will be to synthesise the archaeological, standing building and historical evidence from the Monk Bridge Iron Works. It is proposed that the results of these findings are integrated into a single and final client report. The report will be illustrated with relevant maps, plans, sections and photographs. The report will also fulfil its function as a part of the primary archive of the archaeological evidence.

It is also proposed that the results of the site work be published as a monograph to fit into the 'ARCUS Studies in Historical Archaeology' monograph series.

Given the potentially early dating of the gas regenerative furnaces and their potential with regard to puddling or steel experimentation, it is also proposed that the structural and metallurgical aspects of the gas regenerative furnaces along with the puddling furnaces be reported in a technical journal, such as The Journal of Historical Metallurgy. There is also a potential that cross referencing the archaeometallurgical data with the American data can determine whether iron weld-less tyres produced at the Monk Bridge Iron Works were exported to the USA.

The reporting will have specific research and recording aims which are outlined in the tables below.

9.2 Revised Research Aims and Objectives

A: TECHNOLOGICAL ASPECTS OF PRODUCTION
To produce a coherent account of the archaeological and historical development of the Monk Bridge Iron Works, with particular reference to the technological aspects of production. This will include:
A1: To understand the function of trough structures in Trench A and how these relate to the building.
A2: To understand and confirm the function of the possible tyre blocking press and its workings within its immediate surroundings.
A3: To elucidate the processes taking place at the centre of the Tyre Mill
A4: To understand the function of the un-interpreted structures and engines and clarification of those better understood structures, and how they fit into the work's processes as a whole.
A5: To locate parallels with structures uncovered in the excavations (gas regenerative furnaces, the puddling bases and tyre blocking press) with the archaeological record and written sources.
A6: To understand the construction techniques and inner workings of the gas regenerative furnace and flues found in trenches B3 and D.
A7: To understand the construction techniques and inner workings of the puddling furnaces.
To increase our understanding of the industrial processes taking place as well as characterizing the qualities of metal production in the works
A8: To understand metallurgical analysis of the samples taken from the flues and structural elements to confirm the processes taking place within the features.
A9: To understand metallurgical analysis from slags and flues to confirm the types of metal produced at the works.
A10: To provide a reference database of material analysed.
B: CHRONOLOGY AND ORDERING OF SPACE
To produce a coherent account of the archaeological and historical development of the Monk Bridge Iron Works, with particular reference to the chronological development of the works and its associated buildings. This will include:
B1: To assess the technological aspects of production in relation to the individual structures within recognisable phases of the works' history.
B2: To correlate phases of the building survey and archaeology.
B3: To refine the chronological sequences through material analysis (mainly ceramic and brick).
B4: Critically assess the documentary sources.
B5: To obtain a more complete view of the oil painting.
C: THE WIDER CONTEXTUAL FRAMEWORK
To produce a coherent account of the archaeological and historical development of the Monk Bridge Iron Works, with particular reference to its local, regional, national and international context.
C1: To understand the workings of the Monk Bridge Iron Works to the south of Whitehall Road.
C1: To understand the wider context of the works' periods of use locally and nationally,

considering other contemporary sites within the region.
C2: To cross reference the slags with American data to assess their iron wheels/tyres with the produce from the works and therefore the works' significance internationally.

10 METHOD STATEMENT

10.1 Introduction

The following methods are required to fulfil the revised research aims outlined in Sections 8 and 9 above.

10.2 Management, Monitoring and Review

Management and monitoring tasks have been built into the project. These tasks will include project monitoring, advice and co-ordination, problem solving, and conducting meetings with project staff and all interested external parties.

The project will commence with an initial set-up meeting. In addition, there will be project review meetings, which will take place at regular intervals throughout the preparation of the report. The meetings could potentially involve Rob Kinchin-Smith, Helen Gomersall, specialists and the staff of ARCUS who are working on the project on a regular basis.

10.3 Stratigraphic Analysis

The stratigraphic data recovered from the excavations (as indicated in **Section 5** above) are relatively secure at this stage in the reporting process. However, the matrices that have been produced will need to be checked for consistency prior to publication.

A broad stratigraphic framework has been produced for this assessment, but it is clear that there are some areas where further detailed worked is required, particularly Trench D, which is far more complex in its history. This broad stratigraphic framework will, therefore, be reviewed and refined, and it will also be essential that detailed sub-phasing should be allocated (particularly for Trench D), which will require careful analysis of the primary records, all contexts, and site plans and sections.

The individual Trenching and Strip and Record areas will be considered together to form an analytical sequence across the whole Site. It may be possible to include some of the structures recorded as part of the Standing Building Survey within this matrix.

10.4 Pottery

It is proposed further work should be incorporated into the final report and may be relevant in any future publication. These recommendations are out-lined in **Section 8.2.2** above.

10.5 Metallurgical Analysis

The assemblage contains archaeometallurgically significant material, the analysis of which has the potential to increase the existing knowledge of materials from this period. Recommendations for further work which will be relevant to any further reporting or publication of this material has been out-lined in **Section 8.2.5** above.

10.6 Documentary Analysis

As discussed in **Section 8.4 - Documentation** above, there is considerable scope for further research for inclusion in further reporting and publication. The location and relevance of this material is discussed in **Section 8.4 - Documentation** above.

10.7 Standing Building Survey

Correlations between data recorded during the Standing Building Survey (Jessop and Douglas, forthcoming) and the archaeological data will be assessed. This will involve close comparisons of phasing and sub-phasing between reports. Overlays of the geomatic data from both investigations will be undertaken with reference to historical map and deposited building plans. It will be possible to produce informative above and below ground sections and profiles through the buildings (particularly RPS Building E1). The possibilities of producing 3D cutaways will also be explored.

10.8 Geomatic Data

The geomatic survey data from both standing building survey and archaeological investigation will perform an essential role in the drafting and reproduction of any further work. The production of illustrations and phased plans will be the primary function of the ARCUS Geomatics Department, and will include overlaying field data with historic and Site specific building drawings.

10.9 Publication Text

Following completion of the full analysis of all the stratigraphic and artefactual evidence, a text reporting the results of the evaluation Trenches B1 and C, Excavated Trenches A, B3 and D, the Strip and Record data and where practicable the Standing Building Survey of the former Monk Bridge Iron Works will be undertaken. This will be suitable for eventual publication in monograph form. As specialist reports are received, information of relevance to the interpretation of the stratigraphic sequence and the function of structures will be integrated into the text. In order to discuss fully the regional and national significance of the sites, to find comparators for the excavated data, and to put the sites into context, a degree of library research will be required in order to reference and obtain relevant specialist literature.

The report will be subject to internal revision, and will be submitted to all specialists after editing for their comments. Specialist comments will be written up and integrated with this text to create a single monograph. It is anticipated that some revisions to the text will be likely in light of their comments. It is also likely that some revision of the specialist reports will also be required.

The edited text will only be submitted to a referee for formal review once the above procedure is completed. The referee's and other comments, regarding the volume will be copy edited, typeset, indexed and proof-read to create a text suitable for publication. In addition, catalogues will be prepared for inclusion in electronic format. A suitable cover will be designed incorporating the client's logos and the monograph will be published as part of the 'ARCUS Studies in Historical Archaeology' monograph series.

10.10 Illustration

During each part of the analytical programme, a selection will be made of appropriate material for illustration. This will cover general plans, phase plans, and artefacts. An experienced illustrator, using standard conventions, will compile these illustrations, either digitally, for the plans and sections, or manually, as appropriate.

During preparation of the report text, photographs suitable for inclusion in the publication will be selected from the excavation archive.

11 PUBLICATION SYNOPSIS

11.1 Introduction

It is proposed that the results of the site work be published as a monograph to fit in with the 'ARCUS Studies in Historical Archaeology' monograph series.

It is also proposed that technical aspects of the gas regenerative furnaces and puddling furnaces in tandem with the results of the metallurgical analysis be reported in a technical journal, such as the 'Journal of Historical Metallurgy'.

11.2 Monograph Report Structure

The monograph is unlikely to comprise more than 50,000 words of text, including bibliography, preliminaries and so on. The text will be supported by relevant line drawings, interpretative phase drawings including and any significant artefactual illustrations, and plates.

The report will primarily address the revised research objectives for the project (**Sections 8** and **9** above). The volume will present a closely argued stratigraphic narrative detailing the development of the former Monk Bridge Iron Works, with particular emphasis being placed on the excavated areas. It will also provide an overview and discussion of the finds from the Site, both artefactual and metallurgical, supported by specialist reports on all material categories. The Site will be placed in its local, regional and national context and a discussion will be prepared of the importance of the data in terms of advancing an understanding of the history and development of the study area and of the wider region.

Throughout the project, a high level of communication will be maintained between all members of the project team. It is anticipated that the specialists, especially those with inter-related study areas, will work closely together in order to facilitate integration between material categories, which will be essential in order to meet the research objectives. The finished volume will, therefore, aim to present a high degree of integration between the artefactual, structural and stratigraphic evidence from the Site.

11.3 Outline Synopsis

Preface

Title Page with publication details

Contents

List of Figures

List of Tables

List of Plates

List of Contributors

Acknowledgements

Foreword

Chapter 1: Introduction

1.1 Geology, Topography and Soils

1.2 The Standing Building Survey

12 BIBLIOGRAPHY

Albarella, U. and Davis, S. J. M. 1994. *The Saxon and Medieval animal bones excavated 1985-1989 from West Cotton, Northamptonshire*. AML Report 17/94.

Davis, S. J. M. 1992. *A rapid method for recording information about mammal bones From archaeological sites*. Ancient Monuments Laboratory Report 19/92.

Davies, G., Kinchin-Smith, R., 2006. *Written Scheme of Investigation for the Archaeological Evaluation and Mitigation of Land at Monk Bridge Iron Works, Whitehall Road, Leeds*. ARCUS/RPS Unpublished Report (ARCUS/RPS WSI).

Davies, G., Kinchin-Smith, R., 2006. *Monk Bridge Iron Works, Leeds, Sampling Strategy for Industrial Residues.* ARCUS/RPS Unpublished Report (ARCUS/RPS 2006, App 1.2)

Dransfield,N., McCoy, M., and Davies, G., 2006. *Interim Assessment of Archaeological Evaluations at Monk Bridge Forge, Whitehall Road, Leeds, South Yorkshire*. ARCUS Unpublished Report 971b.1(1)

English Heritage, 1995. *A Strategy for the Care and Investigation of Finds*.

English Heritage, 2002. *Environmental Archaeology. A guide to the theory and practice of methods, from sampling and recovery to post-excavation*.

Fitzgerald, R., 2004. *Archaeological Desktop Assessment of the Monkbridge Ironworks, Whitehall Road, Leeds*. Structural Perspectives Ltd., Unpublished Report.

Gordon R.B., 1997. *Process Deduced from Iron-making Wastes and Artefacts*. Journal of Archaeological Science, 24: 9-18.

IFA (Institute of Field Archaeologists), 1997. *Code of Conduct*.

IFA (Institute of Field Archaeologists), 1999. *Standard and Guidance for Archaeological Evaluation*.

Jessop, O. and Douglas, M. (forthcoming). *Archaeological Building Recording of Monk Bridge Forge, Whitehall Road, Holbeck, Leeds, West Yorkshire.* ARCUS unpublished Report number 971.1 (2).

Kinchin-Smith, R., 2004. *Monk Bridge Forge: Historic Building Assessment*. RPS unpublished report.

Shelton P.W., Clark E.F., Heward P., and Almond J.K., 2002. *Metallurgical Evaluation of the Tyre of Lion Locomotive.* Transactions of the Newcomen Society, 73 (2001-2002): 71-94.

UKIC (United Kingdom Institute of Conservation), 1990. *Guidelines for the Preparation of Excavation Archives for Long Term Storage*.

West Yorkshire Archaeology Advisory Service (WYAAS), 2006. *Specification for an Archaeological Excavation at Monk Bridge Ironworks (Doncasters), Whitehall Road, Leeds.* WYAAS Unpublished Report.

13 PLATES

Plate 1: Facing site N, showing engine mounting [6099] exposed during the strip and record on Area 3. This mounting was located almost centrally within Building E1 and may well have had three separate machines above it. Note that the large crane base was located in the lower left corner and the open sided engine house from trench B3 was located just to the northeast of the scale.

Plate 2: Trench A, facing site WNW. Showing the partially excavated U-Shaped building. Note the earlier long rectangular troughs (A) of phase 1 with the overlying phase 3 brick 'cells' (C) to the left foreground. Note the locations of the small crane base (1) and the large crane base (2).

Plate 3: Facing site WSW, showing the large crane base in Trench A. Note the circular groove and fixing bolts.

Plate 4: Facing site N. Showing the gas regenerative furnace in trench B3 after excavation. Note the four chambers. The two outer 'hot air' chambers were narrower and showed a higher degree of vitrification than those of the 'cold air' chambers in the middle. The in/out-let flue cellar was located in front of the furnace and the engine room was located immediately beyond. Note the structural support girder (A).

Plate 5: Facing site S. Showing the lattice or 'checkerboard' bricks within the western cold and hot air chambers.

Plate 6: Facing site NW. Showing one of the flue voids entering the gas regenerator's eastern cold air chamber from the flue cellar. Note the arch built into the fabric of the connecting wall.

Plate 7: Facing site E. Showing the engine mounting 6105 with trapezoidal fixing bolts. Uncovered as part of strip and record Area 3, Trench B3 (behind) was backfilled for safety purposes.

Plate 8: Facing site W. Showing the probable puddling furnace base 6179/6124/6179. Note the narrowing of the brick walling at the top of the photograph indicating the neck or exhaust end of the structure. Note also the slag lumps at the exhaust end of the structure.

Plate 9: Facing site E. Showing the possible tyre blocking press to south of trench B1.

Plate 10: Facing site W. Showing the engine base and wheel pit (front) in Trench C. Note the four fixing bolts embedded in the sandstone blocks.

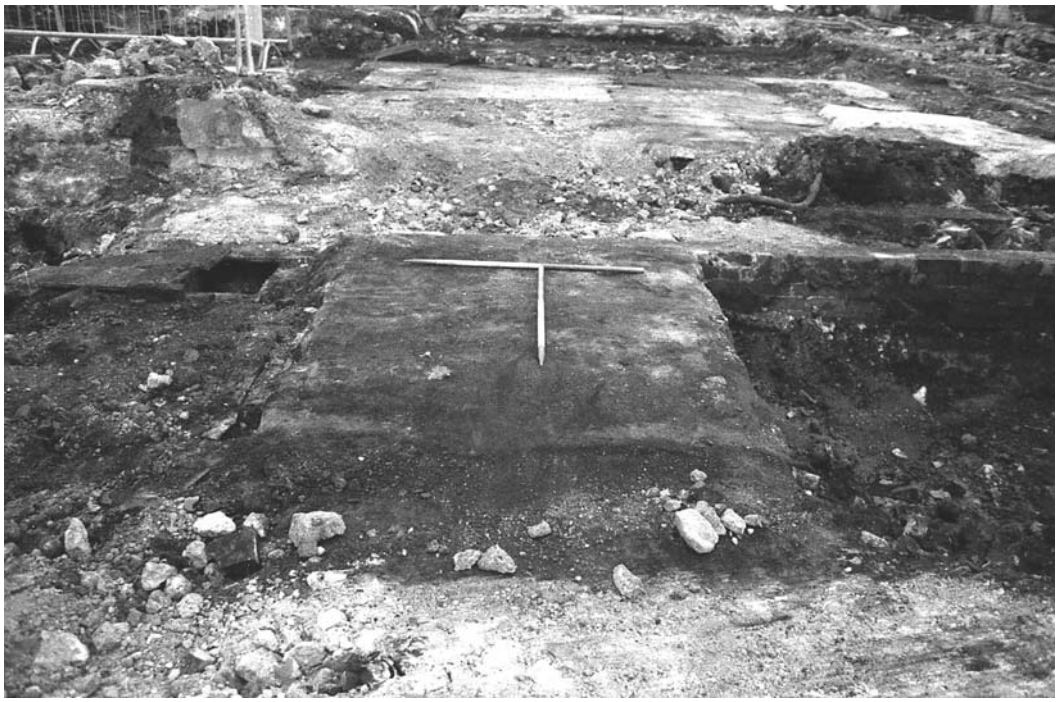

Plate 11: Facing site N. Showing the western support block 6023 of the hammer base uncovered in Strip and Record Area 1b.

Plate 12: Facing site N. Showing the eastern support block 6024 of the hammer base uncovered in Strip and Record Area 1b.

Plate 13: Facing site E. Showing part of the possible rolling mill stand 6020/6035 looking towards Trench C. This structure was uncovered in Strip and Record Area 1b and was linked to the bases uncovered in Trench C.

Plate 14: Facing site N. Showing bases 6018/6019 recovered in Strip and Record Area 1b.

Plate 15: Facing site NW. Showing the chimney base 6070 uncovered during the Strip and Record Area 1b

Plate 16: Facing site E. Showing crane base 6068 which was uncovered on the Strip and Record Area 2b. Note the circular fixing bolts and the grooved indentation on the right side of the sandstone blocks.

Plate 17: Facing site SSW. Showing the large modern tanks (A – D) possibly associated with the Doncasters factory on strip & record Area 2. Note that the features were being recorded whilst ground reduction was taking place.

Plate 18: Facing site SE. Showing the cross struts (B) between the large stone walls (A) forming a possible early boiler base. The heavy heat damage is noticeable as pink discolouration and was also evident on the brick furnace floor (C). Note also the north western corner of Chimney III (D) and the phase 3 boiler base (F) with the boiler support cross struts (E).

Plate 19: Facing site S, showing the location of the phase 3 puddling bases (A-F) either side of chimneys I-III. Note the locations of 1st phase wall 1 (*), the 2nd phase gas regenerative furnaces (**), the puddle drains (#) and the steam hammer base.

Plate 20: Facing site W. Showing the south eastern corner of the pyramidal sandstone foundations of Chimney III. Note the sandstone foundations at the eastern end of the first phase wall 4 (4191) to the left of the photograph. Note also the heat affected nature of the construction backfill between the two structures which indicates their contemporaneity.

Plate 21: Facing site WNW. Showing culvert south extending from chimney III (top right) to the coal cellar and doorway to possible flue cellar (bottom left). Note modern building 4241 (left centre) and the Alpha regenerative furnace above this.

Plate 22: Facing site W. Showing a profile through the Alpha gas regenerative furnace. Note the brick arch extending to the right of the photograph suggesting further chambers to the north. Note also the difference in the widths of the hot air chamber to the left and the cold air chamber to the right.

Plate 23: Facing site N. Showing the flues in the upper part of gas regenerator Alpha prior to excavation. These flues linked the hot and cold air chambers beneath (see plate 15 above) allowing hot air to circulate around the structure.

Plate 24: Facing site NW. Showing gas regenerative furnace Beta with gas regenerative furnace Alpha to the top right of the picture. Note the large pipe truncation between these two furnaces in line with the floor scale.

Plate 25: Facing site E. Showing the brick blocked access arches from the cellar located at the west of the Beta regenerative furnace.

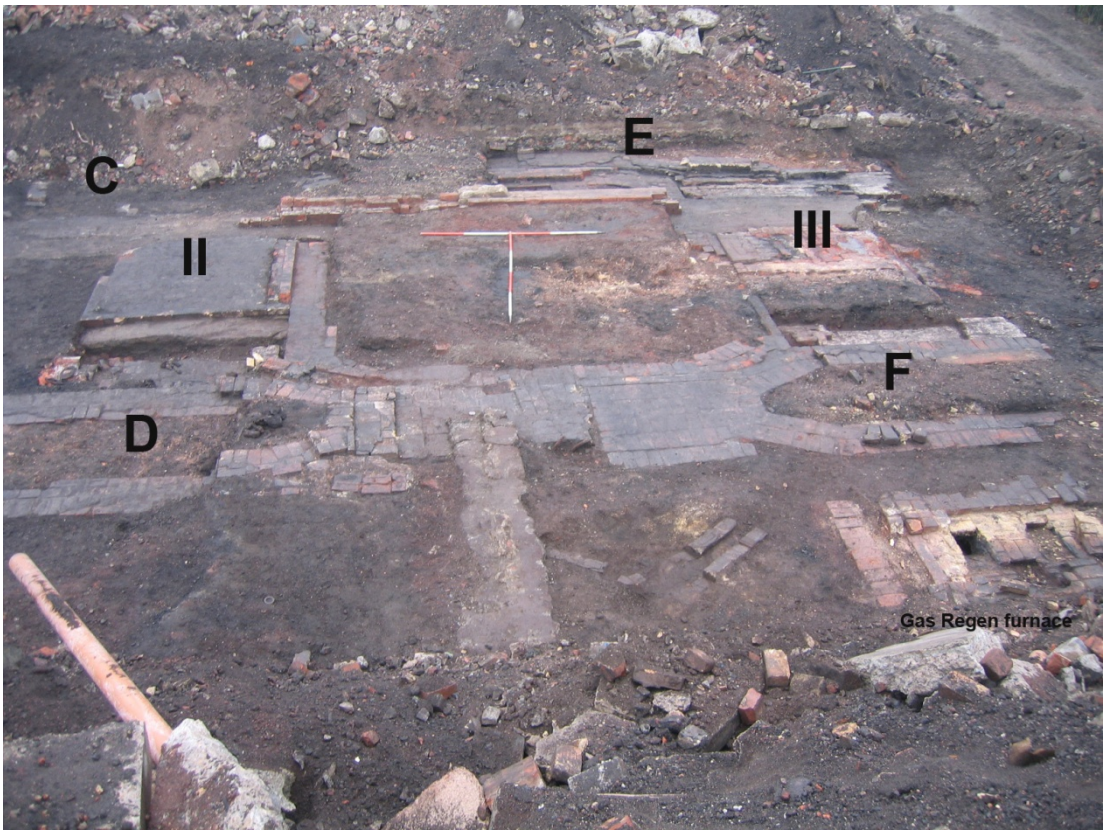

Plate 26: Facing site N. Showing puddle bases D and F linked by a brick surface. Note chimneys II and III with puddle bases C and E in the background. The boiler base was located in the square brick structure linking these features.

Plate 27: Facing site E. Showing the concrete and sandstone of the excavated base of Chimney II. Note the square brick surface on top of the foundations. Note also wall foundations 3 and 4 (to the left and right of respectively) and the manhole relating to the puddling furnace drainage(?) (bottom left).

Plate 28: Facing site W. Showing the brick wall and stepped flooring of the fully excavated puddling furnace base (**F**) (right of picture). Note the top of the arch of one of the cold air chambers of the **Alpha** gas regenerative furnace (left of picture) which is truncated by the insertion of this puddling furnace base.

Plate 29: Facing site NNW. Showing the modern complex of features at the western edge of Trench D. This structure is probably connected to the later 1950s – 1970s Doncasters building identified by RPS as building H.

Plate 30: Facing site W. Showing one of the earliest puddling furnace bases 6161 within Strip and Record Area 2a. Note the later puddling furnace base 6159 at the top of the picture.

Plate 31: Facing site N. Showing the eastern pair of puddling furnace bases [6158 and 6159] uncovered in 'strip and record' Area 2a. Note the brick covered [6160] to the top of the picture (with 1m scale).

Plate 32: Facing site NE. Showing the structure 6160 uncovered during the Strip and Record Area 2a. This structure is depicted as early as 1888 and may have associations with the iron puddling process.

Plate 33: Facing site S. Showing the partially excavated curving flue 6058 and squared brick chimney 6059 (top of picture) which were uncovered during the early watching brief. It is possible that these structures may be linked to the earliest puddling phase of operation under Stephen Witham.

14 ILLUSTRATIONS

All illustrations are orientated to O.S. north.

APPENDIX 1: CONTEXT LIST

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench A	1000	Dep	Rubble / made ground overburden	
971b	Trench A	1001	Str	Sandstone crane base	
971b	Trench A	1002	Str	E limit of square cells and troughs	Machine made, unfrogged r/b
971b	Trench A	1003	Str	NW corner of crane base walling	Machine made, unfrogged r/b
971b	Trench A	1004	Str	SW corner of crane base walling	Machine made, unfrogged r/b
971b	Trench A	1005	Str	S wall of square brick cells	Machine made, unfrogged r/b
971b	Trench A	1006	Str	Possible storage or support cell	Machine made, unfrogged r/b
971b	Trench A	1007	Str	Possible storage or support cell	Machine made, unfrogged r/b
971b	Trench A	1008	Str	Possible storage or support cell	Machine made, unfrogged r/b
971b	Trench A	1009	Str	Possible storage or support cell	Machine made, frogged r/b
971b	Trench A	1010	Str	Possible storage or support cell	Machine made, frogged r/b
971b	Trench A	1011	Str	Possible storage or support cell	Machine made, frogged r/b
971b	Trench A	1012	Str	Possible storage or support cell	Machine made, frogged r/b
971b	Trench A	1013	Str	Possible storage or support cell	Machine made, frogged r/b
971b	Trench A	1014	Str	Possible storage or support cell	Machine made, frogged r/b
971b	Trench A	1015	Str	Possible storage or support cell	Machine made, frogged r/b
971b	Trench A	1016	Dep	Upper slag rich fill of [1009]	
971b	Trench A	1017	Dep	Lower (primary) fill of [1009]	
971b	Trench A	1018	Dep	Upper sandy / rubble fill of [1008]	
971b	Trench A	1019	Dep	Lower (primary) fill of [1008]	
971b	Trench A	1020	Str	S limit of early rectangular troughs	Handmade red brick
971b	Trench A	1021	Dep	Upper slag rich fill of S trough	
971b	Trench A	1022	Dep	Middle fill of S trough	
971b	Trench A	1023	Str	A internal division of early troughs	Hand made red brick
971b	Trench A	1024	Str	Wider central division of troughs	Hand made red brick
971b	Trench A	1025	Str	N internal division of early troughs	Hand made red brick
971b	Trench A	1026	Str	W limit of later brick cells	Machine made, frogged r/b

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench A	1027	Str	W limit of later brick cells and troughs	Machine made, frogged r/b
971b	Trench A	1028	Str	W exterior wall to early troughs	Hand made red brick
971b	Trench A	1029	Str	Addition to wall [1030]	Hand made red brick
971b	Trench A	1030	Str	N wall to early troughs	Hand made red brick
971b	Trench A	1031	Str	S trough	
971b	Trench A	1032	Str	E exterior wall of early troughs	Hand made red brick
971b	Trench A	1033	Str	Lime mortared brick surface on [1046]	Hand made red brick
971b	Trench A	1034	Str	E external wall to W brick cells	Machine made, unfrogged r/b
971b	Trench A	1035	Str	E-W return of [1034] linking to E walling [1037]	Machine made, unfrogged r/b
971b	Trench A	1036	Str	Small sandstone crane base	
971b	Trench A	1037	Str	E external walling to phase 2 troughs	Machine made, unfrogged r/b
971b	Trench A	1038	Str	N external walling to phase 2 troughs	Machine made, unfrogged r/b
971b	Trench A	1039	Str	Later wall extension to phase 1 troughs	Machine made, unfrogged r/b
971b	Trench A	1040	Str	Small segment of wall between 1039 & 1043	Hand made red brick
971b	Trench A	1041	Str	Possible brick manhole to drain	Hand made red brick
971b	Trench A	1042	Str	Possible brick manhole to drain	Hand made red brick
971b	Trench A	1043	Str	W exterior wall of later brick cells	Machine made, unfrogged r/b
971b	Trench A	1044	Void	Void	
971b	Trench A	1045	Str	S exterior wall of later brick cells	Machine made, unfrogged r/b
971b	Trench A	1046	Dep	Second made ground episode	
971b	Trench A	1047	Cut	Cut for [1041] and [1042]	
971b	Trench A	1048	Dep	Clay packing of [1047]	
971b	Trench A	1049	Dep	Post demolition backfill between [1023] and [1024]	
971b	Trench A	1050	Dep	Post demolition backfill between [1024] and [1025]	
971b	Trench A	1051	Dep	Post demolition backfill between [1025] and [1030]	
971b	Trench A	1052	Str	N wall of later brick cells	Machine made, unfrogged r/b
971b	Trench A	1053	Str	E internal division of later brick cells	Machine made, unfrogged r/b

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench A	1054	Str	Internal division to W of 1053	Machine made, unfrogged r/b
971b	Trench A	1055	Str	Internal division to W of 1054	Machine made, frogged r/b
971b	Trench A	1056	Str	Internal division to W of 1055	Machine made, frogged r/b
971b	Trench A	1057	Str	Internal division between 1053 & 1002	Machine made, frogged r/b
971b	Trench A	1058	Str	Internal division between 1053 & 1054	Machine made, frogged r/b
971b	Trench A	1059	Str	Internal division between 1055 & 1056	Machine made, frogged r/b
971b	Trench A	1060	Dep	Post demolition backfill in [1006]	
971b	Trench A	1061	Dep	Post demolition backfill in [1007]	
971b	Trench A	1062	Dep	Post demolition backfill in [1010], [1011], [1013], [1015]	
971b	Trench A	1063	Dep	Post demolition backfill in [1012]	
971b	Trench A	1064	Dep	Post demolition backfill in [1014]	
971b	Trench A	1065	Str	Brick celled structure	Machine made, frogged r/b
971b	Trench A	1066	Dep	Black ash mortar surface	
971b	Trench A	1067	Dep	Post demolition backfill in [1011]	
971b	Trench A	1068	Dep	Post demolition backfill in [1013]	
971b	Trench A	1069	Dep	Post demolition backfill in[1015]	
971b	Trench A	1070	Dep	Primary fill of [1010]	
971b	Trench A	1071	Dep	Primary fill of [1011]	
971b	Trench A	1072	Dep	Primary fill of [1014]	
971b	Trench A	1073	Dep	Primary fill of [1015]	
971b	Trench A	1074	Dep	Primary fill below [1050]	
971b	Trench A	1075	Dep	Mortar layer	
971b	Trench A	1076	Dep	Clinker levelling/bedding layer	
971b	Trench A	1077	Str	Central E-W brick cell division	Machine made, frogged r/b
971b	Trench A	1078	Str	Continuation of wall 1056	Machine made, frogged r/b
971b	Trench A	1079	Str	Series of RB cells between [1045],[1034],[1035] and [1059]	Machine made, frogged r/b
971b	Trench A	1080	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1081	Dep	Post demolition backfill of cells [1079]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench A	1082	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1083	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1084	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1085	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1086	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1087	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1088	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1089	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1090	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1091	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1092	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1093	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1094	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1095	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1096	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1097	Dep	Post demolition backfill of cells [1079]	
971b	Trench A	1098	Str	E-W RB wall forming N boundary of [1079]	Stamped – A.N.B & Co. r/b
971b	Trench A	1099	Str	Sandstone block under SW of [1039]	
971b	Trench A	1100	Dep	Sandy clay partially over [1098] and [1079]	
971b	Trench A	1101	Str	S limit of 2nd phase rectangular troughs	Hand made red brick
971b	Trench A	1102	Str	Internal division N of 1101	Hand made red brick
971b	Trench A	1103	Str	Internal division N of 1102	Hand made red brick
971b	Trench A	1104	Str	Internal division N of 1103	Hand made red brick
971b	Trench A	1105	Dep	Backfill between [1101] and [1102]	
971b	Trench A	1106	Dep	Backfill between [1102] and [1103]	
971b	Trench A	1107	Dep	Backfill between [1103] and [1104]	
971b	Trench A	1108	Str	RB wall bounding [1001] to the SE	Machine made, frogged r/b
971b	Trench A	1109	Str	RB wall bounding [1001] to the NE	Machine made, frogged r/b
971b	Trench A	1110	Str	Large concrete rectangular "tank" NW of trench	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench A	1111	Str	N limit of 2nd phase rectangular troughs	Machine made, frogged r/b
971b	Trench A	1112	Str	Later brick cell division at NW corner	Machine made, frogged r/b
971b	Trench A	1113	Str	Later brick cell division at NW corner	Machine made, frogged r/b
971b	Trench A	1114	Str	Later brick cell division at NW corner	Machine made, frogged r/b
971b	Trench A	1115	Dep	Fill between [1114],[1113],[1038] and [1043]	
971b	Trench A	1116	Dep	Fill between [1114],[1113],[1038] and [1043]	
971b	Trench A	1117	Str	Concrete raft foundation under [1079]	
971b	Trench A	1118	Dep	Clay deposit base of 1101 & 1102	
971b	Trench A	1119	Dep	Clinker under 2nd phase rectangular troughs	
971b	Trench A	1120	Dep	Metallic deposit under [1119]	
971b	Trench A	1121	Dep	Lime mortar spread under [1120]	
971b	Trench A	1122	Str	RB structure in 1123	Machine made, frogged r/b
971b	Trench A	1123	Cut	Construction cut for [1122]	
971b	Trench A	1124	Dep	Clay packing around 1122	
971b	Trench A	1125	Dep	1st phase made ground	
971b	Trench A	1126	Dep	Made ground	
971b	Trench A	1127	Str	Sandstone foundation for [1036]	
971b	Trench A	1128	Dep	Natural - sandy clay	
971b	Trench A	1129	Str	E external wall of 2nd phase troughs	Hand made red brick
971b	Trench A	1130	Str	W external wall of 2nd phase troughs	Hand made red brick
971b	Trench A	1131	Dep	Lower fill above 1066	
971b	Trench A	1132	Cut	Construction cut for [1034]	
971b	Trench A	1133	Dep	Construction cut backfill	
971b	Trench A	1134	Dep	Primary construction cut backfill	
971b	Trench A	1135	Dep	1st phase made ground upper layer	
971b	Trench A	1136	Dep	2nd phase made ground middle layer	
971b	Trench A	1137	Dep	3rd phase made ground lower layer	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench A	1138	Cut	Construction cut for 1027	
971b	Trench A	1139	Dep	Construction cut backfill 1138	
971b	Trench A	1140	Cut	Cut for walls [1004] and [1002] & crane base	
971b	Trench A	1141	Dep	Upper fill of [1140]	
971b	Trench A	1142	Dep	Lower fill of [1140]	
971b	Trench A	1143	Cut	Construction cut for [1037]	
971b	Trench A	1144	Dep	Fill of [1143]	
971b	Trench A	1145	Cut	Construction cut for [1129]	
971b	Trench A	1146	Dep	Fill of [1145]	
971b	Trench A	1147	Dep	Mortar deposit E of [1129]	
971b	Trench B1	2000	Dep	Rubble overburden	
971b	Trench B1	2001	Str	N wall of furnace	Machine made fire brick
971b	Trench B1	2002	Str	E vaulted roof over furnace	Machine made fire brick
971b	Trench B1	2003	Str	W vaulted roof over furnace	Machine made fire brick
971b	Trench B1	2004	Str	W wall of furnace	Machine made fire brick
971b	Trench B1	2005	Str	Part of S wall of furnace	Machine made fire brick
971b	Trench B1	2006	Str	Linking wall between 2004 & 2008	Degraded
971b	Trench B1	2007	Str	Internal wall of furnace cellar	Mixture of fire and hand made r/b
971b	Trench B1	2008	Str	E wall of furnace cellar	Hand made red brick
971b	Trench B1	2009	Void	Void	Hand made red brick
971b	Trench B1	2010	Str	Wall repair - part of E cellar wall	
971b	Trench B1	2011	Str	W wall of engine house	
971b	Trench B1	2012	Str	S wall of furnace cellar	Mixture frogged & hand made r/b
971b	Trench B1	2013	Str	Modern wall poss associated with column 2036	Machine made frogged brick r/b
971b	Trench B1	2014	Str	Part of S wall of furnace	Fire brick
971b	Trench B1	2015	Str	N wall of engine house	
971b	Trench B1	2016	Str	Brick and concrete rectangle S of [2015]	Machine made frogged red brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B1	2017	Str	Large sandstone blocks S of [2016] - Engine base	
971b	Trench B1	2018	Str	Concrete surface over parts of [2017]	
971b	Trench B1	2019	Str	FB built structure S of E end of [2015]	Fire brick, fragments
971b	Trench B1	2020	Str	Lime mortared r/b butts W side of [2019]	Hand made red brick
971b	Trench B1	2021	Str	RB structure S side of [2020]	Machine made frogged red brick
971b	Trench B1	2022	Str	Small sandstone block S of [2019]	
971b	Trench B1	2023	Str	E-W modern RB wall NE of trench	Machine made frogged red brick
971b	Trench B1	2024	Str	Part of N manhole wall	Machine made frogged red brick
971b	Trench B1	2025	Str	Part of N manhole wall	Machine made frogged red brick
971b	Trench B1	2026	Str	E manhole wall	Machine made frogged red brick
971b	Trench B1	2027	Str	Possible drainage channel wall	Machine made frogged red brick
971b	Trench B1	2028	Str	Concrete N of [2024, 2025, 2027]	
971b	Trench B1	2029	Void	Void	
971b	Trench B1	2030	Dep	Clinker rich deposit	
971b	Trench B1	2031	Dep	Red sandy deposit surrounding [2004] and [2001] (N of furnace)	
971b	Trench B1	2032	Dep	Pinkish gritty sand surrounding [2017]	
971b	Trench B1	2033	Dep	Sooty clinker S of [2015]	
971b	Trench B1	2034	Dep	Sandy / clay within FB structure	
971b	Trench B1	2035	Str	Iron and concrete pipe insertion E of [2011]	
971b	Trench B1	2036	Str	Fe metal girder (column support for roof)	
971b	Trench B1	2037	Str	E-W Fe pipe	
971b	Trench B1	2038	Str	Part of S wall of furnace	Machine made fire brick
971b	Trench B3	2500	Dep	Rubble overburden	
971b	Trench B3	2501	Str	Upper S wall of gas regenerator - encasing upper furnace str's	Machine made fire brick
971b	Trench B3	2502	Str	Part of N wall of gas regenerator (NW)	Machine made fire brick
971b	Trench B3	2503	Str	W upper brick arch & vaulted roof of Gas regenerator	Machine made fire brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2504	Str	Modern, poured concrete slab around cast iron support	
971b	Trench B3	2505	Str	Vaulted furnace roof	Machine made fire brick
971b	Trench B3	2506	Str	W vaulting over W cold air chamber	Machine made fire brick
971b	Trench B3	2507	Str	Inner furnace wall separating W hot & cold air chambers	Machine made fire brick
971b	Trench B3	2508	Str	Part of inner S wall of gas regenerator	Machine made fire brick
971b	Trench B3	2509	Str	E vaulted roof over W cold air chamber	Machine made fire brick
971b	Trench B3	2510	Str	W vaulted roof over E cold air chamber	Machine made fire brick
971b	Trench B3	2511	Str	Inner dividing wall between cold air chambers	Machine made fire brick
971b	Trench B3	2512	Str	Outer red brick skin of gas regenerator forming N clue cellar wall	Machine made fire brick
971b	Trench B3	2513	Str	Truncated N wall of gas regenerator	Machine made, frogged r/b
971b	Trench B3	2514	Str	E-W concrete capped drain 2579	
971b	Trench B3	2515	Str	E vaulted roof over E cold air chamber	Machine made fire brick
971b	Trench B3	2516	Str	Internal dividing wall between E hot & cold air chambers	Machine made fire brick
971b	Trench B3	2517	Str	Recessed wall between access doors to gas regenerator	Hand made fire brick
971b	Trench B3	2518	Str	E inner wall of gas regenerator	Machine made fire brick
971b	Trench B3	2519	Str	E vaulting over E hot air chamber	Machine made fire brick
971b	Trench B3	2520	Str	Part of inner N wall of gas regenerator	Machine made fire brick
971b	Trench B3	2521	Str	Archway over access door to E cold air chamber	Machine made fire brick
971b	Trench B3	2522	Str	Poss E outer wall of gas regenerator	Machine made fire brick
971b	Trench B3	2523	Str	Red brick wall remnant between 2542 & 2522	Hand made red brick
971b	Trench B3	2524	Str	Frogged RB surface E of [2523]	Hand made red brick
971b	Trench B3	2525	Str	Modern RB wall above 2524	Hand made red brick
971b	Trench B3	2526	Str	Modern manhole N of [2524]	Machine made red brick
971b	Trench B3	2527	Str	E wall of engine house	Hand made red brick
971b	Trench B3	2528	Str	S wall of engine house	Hand made red brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2529	Str	Sandstone foundation/wall under [2527]	
971b	Trench B3	2530	Str	Sandstone foundation/wall under [2528]	
971b	Trench B3	2531	Str	E-W lime mortared s/stone wall = S wall foundations	
971b	Trench B3	2532	Str	N-S return of [2531] - W wall of engine house	
971b	Trench B3	2533	Str	Concrete flooring at site E	
971b	Trench B3	2534	Str	E wall of modern manhole	Machine made, frogged r/b
971b	Trench B3	2535	Str	Part of S wall of modern manhole	Machine made, frogged r/b
971b	Trench B3	2536	Cut	Cut for drain 2638=2562	
971b	Trench B3	2537	Dep	Fill of cut [2536]	
971b	Trench B3	2538	Str	Ceramic Pipe	
971b	Trench B3	2539	Str	Part of S wall of modern manhole	Machine made, frogged r/b
971b	Trench B3	2540	Str	W wall of modern manhole	Machine made, frogged r/b
971b	Trench B3	2541	Void	Void	
971b	Trench B3	2542	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2543	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2544	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2545	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2546	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2547	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2548	Str	Concrete over 2560	
971b	Trench B3	2549	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2550	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2551	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2552	Str	Wall at centre of twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2553	Str	Thin brick edging to twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2554	Str	L-shaped wall at centre/W of twin rectangular structure	Machine made, frogged r/b
971b	Trench B3	2555	Str	N-S fibreglass coated drainage channel	
971b	Trench B3	2556	Dep	Deposit between rectangular structures - soak away fill?	
971b	Trench B3	2557	Str	S wall of rectangular structure	Machine made, frogged r/b
971b	Trench B3	2558	Str	W wall of rectangular structure	Machine made, frogged r/b
971b	Trench B3	2559	Str	N wall of rectangular structure	Machine made, frogged r/b
971b	Trench B3	2560	Dep	Possible soak away fill	
971b	Trench B3	2561	Str	Concrete flooring of modern factory	
971b	Trench B3	2562	Cut	Cut for drain 2564	
971b	Trench B3	2563	Dep	Concrete over drain 2564	
971b	Trench B3	2564	Str	Concrete/ceramic drain within [2562]	
971b	Trench B3	2565	Str	Sandstone block - part of S engine mounting	
971b	Trench B3	2566	Str	Sandstone block - part of S engine mounting	
971b	Trench B3	2567	Str	Sandstone block - part of S engine mounting	
971b	Trench B3	2568	Str	3 x stone blocks - possibly part of engine mounting	
971b	Trench B3	2569	Str	2 x large blocks - E part of engine mounting (see 6105)	
971b	Trench B3	2570	Str	Concrete pad S of [2569]	
971b	Trench B3	2571	Str	S/Stone block with hole S of [2568] - possibly = 6104	
971b	Trench B3	2572	Str	Concrete S of [2571]	
971b	Trench B3	2573	Str	Iron column support - possible SW roof support	
971b	Trench B3	2574	Str	Dressed stone block - part of the N engine mountings	
971b	Trench B3	2575	Str	Modern concrete between 2574 & 2567	
971b	Trench B3	2576	Str	Modern concrete at NW corner of site	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2577	Cut	Cut for drain 2579 through centre of trench	
971b	Trench B3	2578	Dep	Fill of [2577]	
971b	Trench B3	2579	Str	Ceramic pipe within [2577]	
971b	Trench B3	2580	Str	Concrete - upper fill over pipe 2538	
971b	Trench B3	2581	Str	Southernmost flue/void cut through [2506] + [2507] - vent	
971b	Trench B3	2582	Str	Central flue/void cut through [2506] + [2507] - vent	
971b	Trench B3	2583	Str	Northern flue/void cut through [2506] + [2507] – vent	
971b	Trench B3	2584	Dep	Backfill between [2503] + [2505] (W hot air chamber)	
971b	Trench B3	2585	Dep	Backfill between [2506] + [2509] (W cold air chamber)	
971b	Trench B3	2586	Dep	Backfill between [2510] + [2515] (E cold air chamber)	
971b	Trench B3	2587	Dep	Backfill between [2517] + [2519] (E hot air chamber)	
971b	Trench B3	2588	Dep	Clinker/sand/rubble over pipe 2578	
971b	Trench B3	2589	Dep	Made ground prior to concrete slabs and drains	
971b	Trench B3	2590	Dep	Backfill of modern manhole	
971b	Trench B3	2591	Dep	Rubble fill of [2513] - manhole	
971b	Trench B3	2592	Dep	Rubble fill of [2526] - manhole	
971b	Trench B3	2593	Str	Part of N inner wall of gas regenerator	Machine made fire brick
971b	Trench B3	2594	Str	Displaced bricks above wall 2528	Hand made red brick
971b	Trench B3	2595	Str	Firebrick skin between 2508 & 2512	Machine made fire brick
971b	Trench B3	2596	Str	Displaced bricks above 2527	Machine made red brick
971b	Trench B3	2597	Str	Support and structural wall for 2569	Machine made red brick
971b	Trench B3	2598	Str	Checkerboard bricks within W hot air chamber	Machine made fire brick
971b	Trench B3	2599	Str	Checkerboard bricks within W cold air chamber	Machine made fire brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2600	Str	Checkerboard bricks within E cold air chamber	Machine made fire brick
971b	Trench B3	2601	Str	Checkerboard bricks within E hot air chamber	Machine made fire brick
971b	Trench B3	2602	Str	W outer wall of gas regenerator	Hand made red brick
971b	Trench B3	2603	Str	Checkerboard of firebricks	Large fire brick blocks
971b	Trench B3	2604	Str	Bricked up access door to E hot air chamber	Mixture of red & fire brick
971b	Trench B3	2605	Str	Upper bricks blocking access door to E cold air chamber	Mixture of red & fire brick
971b	Trench B3	2606	Str	Part of the outer S wall of the gas regen at E end	Hand made fire brick
971b	Trench B3	2607	Str	Bricks of blocked access door to E cold air chamber	Machine made fire brick
971b	Trench B3	2608	Void	Void	
971b	Trench B3	2609	Dep	Pea-grit & clinker within small channel	
971b	Trench B3	2610	Str	Displaced bricks of [2612]	Machine made fire brick
971b	Trench B3	2611	Str	RB wall (E-W) - possibly forms S wall of channel	Red brick, stamped 'J.M &S'
971b	Trench B3	2612	Str	E wall of the flue cellar	Machine made, unfrogged r/b
971b	Trench B3	2613	Dep	Putty/plaster of paris like deposit @ base of W cold air chamber	
971b	Trench B3	2614	Dep	Upper fill of flue cellar	
971b	Trench B3	2615	Str	Metal girder - possibly support of structure within the flue cellar	
971b	Trench B3	2616	Str	RB surface - possibly forms N of channel with [2611]	Machine made, unfrogged r/b
971b	Trench B3	2617	Str	Firebrick centre support for [2599] checkerboard bricks	Large fire brick blocks
971b	Trench B3	2618	Dep	Backfill within engine house building	
971b	Trench B3	2619	Dep	Swarfy residue in [2531] engine house building	
971b	Trench B3	2620	Str	Sandstone block - part of the N engine mounting	
971b	Trench B3	2621	Str	Sandstone block - part of the N engine mounting, E of gap	
971b	Trench B3	2622	Void	Void	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2623	Void	Void	
971b	Trench B3	2624	Void	Void	
971b	Trench B3	2625	Void	Void	
971b	Trench B3	2626	Void	Void	
971b	Trench B3	2627	Void	Void	
971b	Trench B3	2628	Cut	Cut for drainage at site east	
971b	Trench B3	2629	Cut	Cut for drain from [2630]	
971b	Trench B3	2630	Str	Brick surface beneath modern twin rectangular structures	Mixture of brick fragments
971b	Trench B3	2631	Str	Sandstone "end block" of engine mounting	
971b	Trench B3	2632	Dep	Black clinker around drains [2628] and [2629]	
971b	Trench B3	2633	Str	Sandstone block, possibly part of crane base [6113]	
971b	Trench B3	2634	Str	Possible NW column support of engine house	
971b	Trench B3	2635	Str	Grey mortared structure	Broken red bricks
971b	Trench B3	2636	Str	Mortar slab structure	Broken red & fire bricks
971b	Trench B3	2637	Str	Sandstone block structure	
971b	Trench B3	2638	Dep	Fill between [2637] and [2574] - made ground	
971b	Trench B3	2639	Str	Red brick linking [2640] to [2574]	Machine made, frogged red brick
971b	Trench B3	2640	Str	Red brick rectangular structure, possible machine base	Machine made, frogged red brick
971b	Trench B3	2641	Str	Possibly part of W engine room wall	Hand made red brick
971b	Trench B3	2642	Dep	Engine base foundation/levelling layer	
971b	Trench B3	2643	Str	Upper made ground at NW corner	
971b	Trench B3	2644	Dep	Yellow clay above (2645)	
971b	Trench B3	2645	Dep	Early black clinker - made ground below [2644]	
971b	Trench B3	2646	Str	Cellar flue leading to brick culvert	Shaped fire brick
971b	Trench B3	2647	Str	S wall of cellar between flue [2646] and gas regenerator	Machine made, frogged red brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2648	Str	E-W flue/culvert beneath floor [2650] - to E hot air chamber	Machine made fire brick
971b	Trench B3	2649	Str	N-S flue/culvert beneath floor [2650] - to E hot air chamber	Machine made fire brick
971b	Trench B3	2650	Str	Three course floor of cellar/room to S of gas regenerator	Machine made fire brick
971b	Trench B3	2651	Str	Later E-W RB structure abutting [2597]	Machine made, frogged red brick
971b	Trench B3	2652	Void	Void	
971b	Trench B3	2653	Void	Void	
971b	Trench B3	2654	Str	N-S thick sandstone wall abutting [2633]	
971b	Trench B3	2655	Str	Foundation of N engine mounting blocks	
971b	Trench B3	2656	Dep	Made ground between N & S engine blocks	
971b	Trench B3	2657	Cut	Cut for drain [2564 = 2562]	
971b	Trench B3	2658	Str	Sandstone foundation for S engine mounting blocks	
971b	Trench B3	2659	Cut	Construction cut for manhole [2534/5/9/40]	
971b	Trench B3	2660	Void	Void	
971b	Trench B3	2661	Str	W end wall of gas supply culvert	Machine made, unfrogged r/b
971b	Trench B3	2662	Str	Main brick structure of flue in-let system	Machine made fire brick
971b	Trench B3	2663	Str	Void of E hot air inlet flue	Machine made fire brick
971b	Trench B3	2664	Str	Brick arch of void [2665]	Machine made fire brick
971b	Trench B3	2665	Str	Void of E cold air inlet flue	Machine made fire brick
971b	Trench B3	2666	Dep	Deposit within void [2663]	
971b	Trench B3	2667	Dep	Deposit within void [2665]	
971b	Trench B3	2668	Str	Brick arch flue into [2646 & 2669]	Machine made fire brick
971b	Trench B3	2669	Str	Void - in/out let from [2646]	Machine made fire brick
971b	Trench B3	2670	Dep	Deposit within void [2669] and arch [2668]	
971b	Trench B3	2671	Str	Connecting flue between [2669 & 2672]	Machine made fire brick
971b	Trench B3	2672	Str	Void connected to [2669]	Machine made fire brick
971b	Trench B3	2673	Dep	Deposit within [2672]	
971b	Trench B3	2674	Str	Void leading to flue [2675]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench B3	2675	Str	L-shaped flue to W hot air chamber	Machine made fire brick
971b	Trench B3	2676	Dep	Deposit within void [2674]	
971b	Trench B3	2677	Dep	Collapsed roof of flue [2675]	
971b	Trench B3	2678	Str	Void of W cold air chamber	Machine made fire brick
971b	Trench B3	2679	Str	Brick arch connected to [2678]	Machine made fire brick
971b	Trench B3	2680	Dep	Deposit within void [2678]	
971b	Trench B3	2681	Str	W wall of cellar to S of gas regenerator	Machine made, unfrogged r/b
971b	Trench B3	2682	Str	Red brick blocking access door to furnace	Machine made, unfrogged r/b
971b	Trench B3	2683	Str	Firebrick walling - part of wall between furnace and cellar	Machine made fire brick
971b	Trench B3	2684	Str	Red brick blocking access door to furnace	Machine made, unfrogged r/b
971b	Trench C	3000	Str	Concrete slabbing present across site	
971b	Trench C	3001	Str	Large sandstone machine base	
971b	Trench C	3002	Str	Red brick wall S of [3001]	Hand made red brick
971b	Trench C	3003	Dep	Yellow gravelly deposit beneath 3005	
971b	Trench C	3004	Str	Concrete intrusion E of [3001] with wall footing impression	
971b	Trench C	3005	Str	Concrete spread W of and partially over [3001]	
971b	Trench C	3006	Str	E-W brick structure N of [3001] - N wall of engine house	Hand made red brick
971b	Trench C	3007	Str	Sandstone block N of [3001]	
971b	Trench C	3008	Str	Small sandstone block between [3006] and [3007]	
971b	Trench C	3009	Str	Red brisk str E of [3007] - N wall of engine house outer skins	Hand made red brick
971b	Trench C	3010	Str	Red brick str S from [3009] N wall of engine house inner skins	Hand made red brick
971b	Trench C	3011	Str	N part of E wall of wheel pit wall	Hand made red brick
971b	Trench C	3012	Str	Sandstone axle support in E wall of wheel pit wall	
971b	Trench C	3013	Str	Inner (W) bricks of S part of E wheel pit wall	Hand made red brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench C	3014	Str	Outer (E) bricks of S part of wheel pit wall	Hand made red brick
971b	Trench C	3015	Str	Internal bricks of S part of E wheel pit wall	Hand made red brick
971b	Trench C	3016	Str	N-S modern wall - middle of trench	Machine made frogged r/b
971b	Trench C	3017	Str	Square brick abuttment W of [3016]	Machine made frogged r/b
971b	Trench C	3018	Str	Row of brick and slate W of [3016]	Machine made frogged r/b
971b	Trench C	3019	Str	W exterior wall of electricity sub station	Machine made frogged r/b
971b	Trench C	3020	Str	W wall of poss room within sub station	Machine made frogged r/b
971b	Trench C	3021	Str	S wall of poss room within sub station	Machine made frogged r/b
971b	Trench C	3022	Str	E wall of poss room within sub station	Machine made frogged r/b
971b	Trench C	3023	Str	S exterior wall of electricity sub station	Stamped – red brick 'Armitage'
971b	Trench C	3024	Dep	Clinker / rubble backfill - present across trench	
971b	Trench C	3025	Dep	Fill of 'wheel pit'	
971b	Trench C	3026	Str	E exterior wall of electricity sub station	Machine made frogged r/b
971b	Trench D	4000	Dep	Red pea grit levelling layer - puddle base phase	
971b	Trench D	4001	Dep	Black clinker layer - puddle base phase	
971b	Trench D	4002	Str	N-S brick and mortar Structure @ SW corner of trench	Machine made fire brick
971b	Trench D	4003	Str	NE-SW brick lined pipe @ SW corner of trench	Machine made fire brick
971b	Trench D	4004	Str	N & S side walls of connecting brick surface - **Puddle Base A**	Machine made, unfrogged r/b
971b	Trench D	4005	Str	Part of S side arm wall of **Puddle Base A**	Machine made fire brick
971b	Trench D	4006	Str	Part of N side arm wall of **Puddle Base A**	Machine made, unfrogged r/b
971b	Trench D	4007	Str	Part of S side arm wall of **Puddle Base A**	Machine made fire brick
971b	Trench D	4008	Str	Part of N side arm wall of **Puddle Base A**	Mixture of red & fire brick
971b	Trench D	4009	Str	Concrete floor surface between [4004] + [4009]	
971b	Trench D	4010	Dep	Black clinker infill within support walls of Puddle Base A	
971b	Trench D	4011	Str	Part of connecting brick surface between [4004] - **Puddle Base A**	Variable red brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4012	Str	Part of connecting brick surface between [4004] - **Puddle Base A**	Machine made fire brick
971b	Trench D	4013	Dep	Silt and rubble fill within puddle base neck - **Puddle Base A**	
971b	Trench D	4014	Str	Flat metalled surface in puddle base neck - **Puddle Base A**	
971b	Trench D	4015	Cut	Pit (brick filled)	
971b	Trench D	4016	Fill	Brick/ganister fill of pit [4015]	
971b	Trench D	4017	Str	Sandstone wall foundation part of **1st Phase Wall 2**	
971b	Trench D	4018	Str	Brick wall above [4017] part of **1st Phase Wall 2**	Machine made, unfrogged r/b
971b	Trench D	4019	Str	Cobble surface (heat damaged) centre/W of Trench	
971b	Trench D	4020	Str	FE pipe W of [4017]	
971b	Trench D	4021	Str	Concrete foundation / surround of modern structure at site W	
971b	Trench D	4022	Str	Square brick structure of modern structure at site W	Machine made frogged r/b
971b	Trench D	4023	Str	Red ashlar surface of modern structure at site W	
971b	Trench D	4024	Str	N wall of early? puddle base below **Puddle Base A**	Machine made, unfrogged r/b
971b	Trench D	4025	Str	N - S aligned modern concrete foundation	
971b	Trench D	4026	Str	Square concrete block with slot at S of Tr, E of [4025]	
971b	Trench D	4027	Str	Remnant of concrete flooring N of [4025]	
971b	Trench D	4028	Str	Drain and pipe E of [4025]	Machine made frogged r/b
971b	Trench D	4029	Void	Void	
971b	Trench D	4030	Str	S side wall of **Puddle Base C**	Machine made frogged r/b
971b	Trench D	4031	Str	N side wall of **Puddle Base C**	Machine made frogged r/b
971b	Trench D	4032	Str	W end wall of **Puddle Base C**	Machine made frogged r/b
971b	Trench D	4033	Dep	Clinker and slag fill in Puddle Base C	
971b	Trench D	4034	Str	Flat brick connecting surface between Puddle Bases C & E	Machine made frogged r/b

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4035	Str	Flat brick connecting surface between Puddle Bases C & E	Machine made frogged r/b
971b	Trench D	4036	Str	Possible flue remnant N of [4034] to chimney II	Machine made frogged r/b
971b	Trench D	4037	Str	W wall of **Boiler Base**	Machine made frogged r/b
971b	Trench D	4038	Str	S wall of **Boiler Base**	Machine made frogged r/b
971b	Trench D	4039	Dep	Red pea grit levelling within boiler base	
971b	Trench D	4040	Str	Small frag of brick walling under [4042] - **1st Phase Wall 4**	Machine made unfrogged r/b
971b	Trench D	4041	Str	Sandstone foundation of **Chimney II,** above [4310]	
971b	Trench D	4042	Str	Small N-S brick wall - **1st Phase Wall 4**	Machine made unfrogged r/b
971b	Trench D	4043	Str	Mortar covered brick wall - Part of **1st Phase Wall 4**	Machine made unfrogged r/b
971b	Trench D	4044	Str	Thin corroded metal plate between Puddle Base C & Wall 4	
971b	Trench D	4045	Dep	Brick and rubble fill N of [4043]	
971b	Trench D	4046	Str	Red brick walling - **1st Phase Wall 4**	Machine made unfrogged r/b
971b	Trench D	4047	Str	NW-SE brick structure E of [4050]	Machine made fire brick
971b	Trench D	4048	Cut	Construction cut for modern concrete foundation	
971b	Trench D	4049	Fill	Red pea grit fill W of [4050]	
971b	Trench D	4050	Str	N - S modern concrete foundation	
971b	Trench D	4051	Str	Small E-W brick wall, runs W from [4050]	Machine made unfrogged r/b
971b	Trench D	4052	Str	Metal anchorage supports S of [4035]	
971b	Trench D	4053	Str	Fire brick wall tagged to S brick surface [4063]	Machine made fire brick
971b	Trench D	4054	Str	S side arm wall of **Puddle Base E**	Machine made unfrogged r/b
971b	Trench D	4055	Str	N side arm wall of **Puddle Base E**	Machine made unfrogged r/b
971b	Trench D	4056	Fill	Upper fill within Puddle Base E	
971b	Trench D	4057	Str	E wall of **Boiler Base**	Machine made unfrogged r/b
971b	Trench D	4058	Str	E-W Red brick wall - **1st Phase Wall 4**	Machine made unfrogged r/b
971b	Trench D	4059	Fill	Fill between walls [4058] + [4055] - 1st phase made ground	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4060	Str	W external wall of - **Gas Regen Alpha**	Machine made unfrogged r/b
971b	Trench D	4061	Str	Brick upper with flue vents - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4062	Str	Rail sleeper W of [4055]	
971b	Trench D	4063	Str	Flat brick connecting surface between Puddle Bases C & E	Machine made unfrogged r/b
971b	Trench D	4064	Dep	Black clinker rail sleeper bedding W of Tr.	
971b	Trench D	4065	Cut	Construction cut for heat / flue system [4067-4074] N of [4059]	
971b	Trench D	4066	Fill	Fill of Chimney III structural voids [4074]	
971b	Trench D	4067	Str	SE corner of pyramidal sandstone foundations - **Chimney III**	
971b	Trench D	4068	Str	NE corner of pyramidal sandstone foundations - **Chimney III**	
971b	Trench D	4069	Str	W wall arm of **N Brick Culvert**	Machine made unfrogged r/b
971b	Trench D	4070	Str	Remnant of W brick wall of **S Brick Culvert**	Machine made unfrogged r/b
971b	Trench D	4071	Str	N-S part of heat flue structure, W of [4072]	Machine made unfrogged r/b
971b	Trench D	4072	Str	Part of lower brick surface - **Chimney III**	Machine made unfrogged r/b
971b	Trench D	4073	Str	Part of upper brick surface - **Chimney III**	Machine made unfrogged r/b
971b	Trench D	4074	Cut	Structural voids in upper brick surface - **Chimney III**	
971b	Trench D	4075	Cut	Construction cut for modern building [4076, 4077]	
971b	Trench D	4076	Str	E-W flat modern concrete foundation of wall [4077]	
971b	Trench D	4077	Str	E-W modern brick wall over [4076]	Machine made frogged r/b
971b	Trench D	4078	Str	Sandstone wall foundation part of **1st Phase Wall 3**	
971b	Trench D	4079	Str	Brick wall upper, part of **1st Phase Wall 3**	Machine made unfrogged r/b
971b	Trench D	4080	Cut	Brick wall upper, part of **1st Phase Wall 3**	
971b	Trench D	4081	Str	Brick wall upper, part of **1st Phase Wall 3**	Machine made unfrogged r/b
971b	Trench D	4082	Str	E-W brick wall under S wall of **Puddle Base F**	Machine made frogged r/b
971b	Trench D	4083	Str	S side arm wall of **Puddle Base F**	Machine made fire brick, stamped 'Clifford & Sons'

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4084	Str	W, neck end of **Puddle Base F**	Machine made fire brick
971b	Trench D	4085	Str	Part of flat brick surface connecting Puddle Bases D & F	
971b	Trench D	4086	Str	Part of flat brick surface connecting Puddle Bases D & F	
971b	Trench D	4087	Str	E wall of **boiler base**	Machine made unfrogged r/b
971b	Trench D	4088	Str	N wall of **boiler base**	Machine made unfrogged r/b
971b	Trench D	4089	Str	E internal strut of **boiler base**	Machine made unfrogged r/b
971b	Trench D	4090	Fill	Upper fill of Puddle Base F	
971b	Trench D	4091	Dep	Backfill of modern construction cut [4075]	
971b	Trench D	4092	Dep	Overburden, N of [4091]	
971b	Trench D	4093	Str	NW corner of **boiler base**	Machine made unfrogged r/b
971b	Trench D	4094	Str	Mortar lower bond of brick wall (W continuation of [4077])	
971b	Trench D	4095	Str	S external wall remnant of **Chimney II** base	Machine made unfrogged r/b
971b	Trench D	4096	Str	W external wall remnant of **Chimney II** base	Machine made unfrogged r/b
971b	Trench D	4097	Str	N external wall remnant of **Chimney II** base	Machine made fire brick
971b	Trench D	4098	Str	E external wall remnant of **Chimney II** base	Machine made unfrogged r/b
971b	Trench D	4099	Str	Flat brick surface - base of **Chimney II**	Machine made unfrogged r/b
971b	Trench D	4100	Str	E end wall of **Puddle Base D**	Machine made unfrogged r/b
971b	Trench D	4101	Str	Large square brick manhole between puddle bases A - D	Machine made unfrogged r/b
971b	Trench D	4102	Str	Sandstone foundation for **1st Phase Wall 1**	
971b	Trench D	4103	Str	E end wall of **Puddle Base B**	Machine made fire brick
971b	Trench D	4104	Str	S side arm wall of **Puddle Base B**	Machine made fire brick
971b	Trench D	4105	Str	Concrete ramp surround / end stop of modern structure at site W	
971b	Trench D	4106	Str	Concrete sloping ramp W of modern structure at site W	
971b	Trench D	4107	Str	Internal brick walling S of modern structure at site W	Red brick, partial stamp 'BIRK..'

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4108	Str	Internal brick walling N of modern structure at site W	Machine made frogged r/b
971b	Trench D	4109	Str	Flooring - ashlar of modern structure at site W	
971b	Trench D	4110	Str	Concrete foundation / surround of modern structure at site W	
971b	Trench D	4111	Str	E-W brick walling N of modern structure at site W	Machine made frogged r/b
971b	Trench D	4112	Str	Concrete slab of modern structure at site W	
971b	Trench D	4113	Str	Concrete surface of modern structure at site W	
971b	Trench D	4114	Str	Pink concrete surface of modern structure at site W	
971b	Trench D	4115	Str	Brick walling of modern structure at site W	Machine made frogged r/b
971b	Trench D	4116	Str	Brick surface of modern structure at site W	Machine made frogged r/b
971b	Trench D	4117	Cut	Major modern truncation at E edge of trench	
971b	Trench D	4118	Fill	Post demo fill within Puddle Base C	
971b	Trench D	4119	Str	Rail sleeper N of [4052]	
971b	Trench D	4120	Str	W (N-S) brick wall between the gas regens, parallel to [4122]	Machine made unfrogged r/b
971b	Trench D	4121	Str	Brick floor surface between [4120 & 4122]	Machine made unfrogged r/b
971b	Trench D	4122	Str	E (N-S) brick wall between the gas regens, parallel to [4120]	Machine made unfrogged r/b
971b	Trench D	4123	Str	N outer wall of **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4124	Str	N remnant of vaulting over hot air chamber - **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4125	Str	Concrete in-fill of structural voids S of [4125]	
971b	Trench D	4126	Str	W outer wall of **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4127	Str	E-W brick wall, middle of [4126]	Machine made fire brick
971b	Trench D	4128	Dep	Industrial clinker layer, W of [4132]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4129	Dep	Compact layer of metalled clinker S of [4128]	
971b	Trench D	4130	Str	Brick surface / walling E of [4129]	Machine made fire brick
971b	Trench D	4131	Str	Brick walling / surface E of [4130]	Machine made fire brick
971b	Trench D	4132	Str	Internal wall between N hot & cold air chambers-**Gas Regen Beta**	Machine made fire brick
971b	Trench D	4133	Str	S remnant of vaulting over hot air chamber - **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4134	Str	Flue in/out-let into hot air chamber - **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4135	Cut	Construction cut for modern building S of [4132] &c.	
971b	Trench D	4136	Fill	Construction cut backfill of [4135]	
971b	Trench D	4137	Str	N wall of modern building E-W across extension of trench	Machine made, frogged red brick
971b	Trench D	4138	Str	Westernmost N-S internal wall of modern building, S of [4137]	Machine made, frogged red brick
971b	Trench D	4139	Str	Easternmost N-S internal wall of modern building, S of [4137]	Machine made, frogged red brick
971b	Trench D	4140	Str	N-S E wall of modern building, abuts [4137]	Machine made, frogged red brick
971b	Trench D	4141	Dep	Pea grit and rubble in-fill at S of extension of trench	
971b	Trench D	4142	Dep	Layer of clinker and rubble N of [4137]	
971b	Trench D	4143	Dep	Blackish clinker & silt similar to (4001)	
971b	Trench D	4144	Dep	Fill of cut [4148]	
971b	Trench D	4145	Str	Void within [4132] - possible flue in/out-let - **Gas Regen Beta**	
971b	Trench D	4146	Dep	Backfill of modern truncation [4117]	
971b	Trench D	4147	Str	Remnant of wall in modern truncation in E of extension of trench	Machine made, frogged red brick
971b	Trench D	4148	Cut	Cut for large drain between gas regenerators	
971b	Trench D	4149	Dep	Red ganister made ground between gas regenerators	
971b	Trench D	4150	Str	Burnt brick surface - upper bricks of **Chimney I**	Machine made, unfrogged r/b

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4151	Dep	Fill between wall arms [4069, 4070]	
971b	Trench D	4152	Str	Firebrick vaulted arching of cold air chamber - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4153	Str	Firebrick wall between cold air chambers - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4154	Dep	Reddish black ashy deposit on [4153] - made ground phase 3	
971b	Trench D	4155	Dep	Yellow/brown clay between [4154] & [4001]-made ground phase 3	
971b	Trench D	4156	Dep	Slag layer within Puddle Base E neck	
971b	Trench D	4157	Dep	Grey brown clayey, primary silt within Puddle Base E neck	
971b	Trench D	4158	Dep	Rubble backfill within Puddle Base E	
971b	Trench D	4159	Dep	Pea grit below upper layer [4146]	
971b	Trench D	4160	Dep	Mixed layer between [4064] and [4161]	
971b	Trench D	4161	Dep	Clinker below [4159] - fill of [4148]	
971b	Trench D	4162	Dep	Brick rubble below [4160] - fill of [4148]	
971b	Trench D	4163	Dep	Clay-rich layer under [4162],[4161] - fill of [4148]	
971b	Trench D	4164	Dep	Clinker below [4163] - fill of [4148]	
971b	Trench D	4165	Dep	Brick rubble below [4163]	
971b	Trench D	4166	Dep	Largest backfill layer below [4163]	
971b	Trench D	4167	Dep	Possible disturbance to [4166] below [4166]	
971b	Trench D	4168	Dep	Brick dust rich layer below [4167]	
971b	Trench D	4169	Dep	Clinker below [4168]	
971b	Trench D	4170	Dep	Red coarse sand made ground for [4173]	
971b	Trench D	4171	Dep	Clean silt with pebbles - packing around S Brick Culvert	
971b	Trench D	4172	Dep	Red silty clay with pebbles - packing around S Brick Culvert	
971b	Trench D	4173	Str	Red brick, tar covered floor to coal bunker	Machine made unfrogged r/b
971b	Trench D	4174	Str	Arched roof to **S Brick Culvert**	Shaped red & fire brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4175	Str	Brick floor to **S Brick Culvert**	Machine made unfrogged r/b
971b	Trench D	4176	Str	E side brick wall to **S Brick Culvert**	Machine made unfrogged r/b
971b	Trench D	4177	Str	Continuation of W side wall to **S Brick Culvert**	Machine made unfrogged r/b
971b	Trench D	4178	Void	Void	
971b	Trench D	4179	Dep	Post demolition backfill - Gas Regen Alpha	
971b	Trench D	4180	Str	Lattice brick structure in cold air chamber - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4181	Str	Support firebricks of cold air lattice - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4182	Dep	Red coating of material in cold air chamber - **Gas Regen Alpha**	
971b	Trench D	4183	Dep	Red, below [4059] - made ground phase 1	
971b	Trench D	4184	Dep	Mortar layer below [4183] - made ground phase 1	
971b	Trench D	4185	Dep	Half- brick layer below [4184] - made ground phase 1	
971b	Trench D	4186	Dep	Clinker layer - made ground phase 1	
971b	Trench D	4187	Dep	Fe rich concretion over natural	
971b	Trench D	4188	Dep	**Natural** - grey sandy clay	
971b	Trench D	4189	Dep	Black compact clinker layer in Puddle Base C	
971b	Trench D	4190	Dep	Primary backfill - made ground phase 1	
971b	Trench D	4191	Str	Sandstone foundation of [4058] - **1st Phase Wall 4**	
971b	Trench D	4192	Dep	Primary fill within Puddle Base C neck	
971b	Trench D	4193	Str	Brick floor surface within **Puddle Base C**	Machine made unfrogged r/b
971b	Trench D	4194	Str	Part of flat brick surface connecting Puddle Bases D & F	Machine made fire brick
971b	Trench D	4195	Str	S side arm wall of **Puddle Base D**	Machine made fire brick
971b	Trench D	4196	Str	N side arm wall of **Puddle Base D**	Machine made, unfrogged r/b
971b	Trench D	4197	Str	N side arm wall of **Puddle Base B**	Machine made, frogged r/b
971b	Trench D	4198	Cut	Disturbed ground at site north	
971b	Trench D	4199	Dep	Fill of [4198]	
971b	Trench D	4200	Str	Rectangular brick structure	Machine made fire brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4201	Str	Dog legged brickwork to W of [4200]	Machine made, frogged r/b
971b	Trench D	4202	Str	Brick walling (1st phase Wall 3?) later used as phase 3 flue base?	Machine made, unfrogged r/b
971b	Trench D	4203	Str	Fragment of wall abutting W of [4202]	Machine made, unfrogged r/b
971b	Trench D	4204	Str	Mortar covered sandstone foundation - part of **1st Phase Wall 3**	Machine made, unfrogged r/b
971b	Trench D	4205	Str	Sandstone bonded to surface [4204] - part of **1st Phase Wall 3**	
971b	Trench D	4206	Str	Brick walling terminus - probably W end of **1st Phase Wall 3**	Machine made, unfrogged r/b
971b	Trench D	4207	Str	Early ? Puddle wall under S of **Puddle Base D**	Machine made, unfrogged r/b
971b	Trench D	4208	Dep	Upper fill in Puddle Base D	
971b	Trench D	4209	Str	Modern concrete drainage channel	
971b	Trench D	4210	Cut	Construction cut for modern wall [4211]	
971b	Trench D	4211	Str	Modern brick wall at site NE	Machine made, unfrogged r/b
971b	Trench D	4212	Dep	Concrete foundation of [4211]	
971b	Trench D	4213	Dep	Deposit between [4211] and [4214]	
971b	Trench D	4214	Str	E wall of culvert	Red brick, stamped 'J.M & S'
971b	Trench D	4215	Str	W wall of culvert	Red brick, stamped 'J.M & S'
971b	Trench D	4216	Dep	Fill of culvert and metal plate covers	
971b	Trench D	4217	Cut	Drain cut, associated with [4215]	
971b	Trench D	4218	Str	Metal drain/pipe	
971b	Trench D	4219	Str	Brick lined drain/pipe channel	Machine made, unfrogged r/b
971b	Trench D	4220	Dep	Foundation layer beneath [4178] **S Brick Culvert**	
971b	Trench D	4221	Dep	Made ground beneath **S Brick Culvert**	
971b	Trench D	4222	Dep	Compressed hammerscale surface	
971b	Trench D	4223	Str	E end wall of **Puddle Base A**	Machine made, unfrogged r/b
971b	Trench D	4224	Str	Modern concrete capping on [4225]	
971b	Trench D	4225	Str	Fe plate capping [4226]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4226	Str	Rectangular brick drain surround of Puddle Bases A & C	Machine made, unfrogged r/b
971b	Trench D	4227	Dep	Deposit within building [4200]	
971b	Trench D	4228	Dep	Drain floor of Puddle Bases A & C	
971b	Trench D	4229	Str	Timber railway sleeper	
971b	Trench D	4230	Str	W cross-strut of **Boiler Base**	Machine made, unfrogged r/b
971b	Trench D	4231	Dep	Clinker deposit within boiler base	
971b	Trench D	4232	Dep	Red pea grit fill within boiler base	
971b	Trench D	4233	Dep	Red pea grit within Boiler Base	
971b	Trench D	4234	Str	Sandstone foundation of W wall of **1st Phase Furnace Room**	
971b	Trench D	4235	Str	Sandstone foundation of E wall of **1st Phase Furnace Room**	
971b	Trench D	4236	Dep	Highly compact layer under [4038] - levelling layer for boiler base	
971b	Trench D	4237	Str	Lower brick floor of **Puddle Base E**	Machine made, unfrogged r/b
971b	Trench D	4238	Str	Upper brick floor of **Puddle Base E**	Machine made, unfrogged r/b
971b	Trench D	4239	Str	E wall of possible Flue Cellar with metal door opening	Machine made, unfrogged r/b
971b	Trench D	4240	Cut	Construction cut for building [4241]	
971b	Trench D	4241	Str	Modern red brick structure	Red brick, stamped 'BIRKBY'S LTD – WYKE'
971b	Trench D	4242	Str	Concrete surround of [4241]	
971b	Trench D	4243	Str	Drain at E end of **Puddle Base E**	Machine made, unfrogged r/b
971b	Trench D	4244	Str	Concrete cut through [4173]	
971b	Trench D	4245	Dep	Infill between drain [4243] & flue cellar wall [4270]	
971b	Trench D	4246	Str	Brick row	Machine made, unfrogged r/b
971b	Trench D	4247	Str	E wall of brick column surround	Machine made, unfrogged r/b
971b	Trench D	4248	Str	W wall of brick column surround	Machine made, unfrogged r/b
971b	Trench D	4249	Str	N wall of brick column surround	Machine made, unfrogged r/b
971b	Trench D	4250	Str	Sandstone support for [4249]	
971b	Trench D	4251	Str	Concrete slab	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4252	Dep	Mortar layer	
971b	Trench D	4253	Str	Level brick surface	Machine made fire brick
971b	Trench D	4254	Dep	Metalled slag on E steam hammer arm base	
971b	Trench D	4255	Dep	Metalled slag on E steam hammer arm base	
971b	Trench D	4256	Str	Sandstone slabs forming E edge of E **steam hammer arm base**	
971b	Trench D	4257	Str	Sandstone slabs forming N edge of E **steam hammer arm base**	
971b	Trench D	4258	Str	Sandstone slab machine base of E **steam hammer arm base**	
971b	Trench D	4259	Dep	Metalled slag on E steam hammer arm base	
971b	Trench D	4260	Cut	Cut for drainage pipe trench	
971b	Trench D	4261	Str	Brick row	Machine made, unfrogged r/b
971b	Trench D	4262	Dep	Fragment of mortar layer	
971b	Trench D	4263	Dep	Deposit within square structure [4247/48/49]	
971b	Trench D	4264	Dep	Upper demo deposit within E steam hammer arm base void	
971b	Trench D	4265	Str	Firebrick lattice - **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4266	Str	Walls and chamber of - **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4267	Str	Vaulting over cold air chamber - **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4268	Dep	Post demo infill of - Gas Regen Beta	
971b	Trench D	4269	Str	Walls either side of cold air chamber - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4270	Str	N wall of possible flue cellar	Machine made, unfrogged r/b
971b	Trench D	4271	Str	Firebrick vaulting over hot air chamber - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4272	Void	Void	
971b	Trench D	4273	Dep	Black ashy made ground between gas regenerators	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4274	Void	Void	
971b	Trench D	4275	Void	Void	
971b	Trench D	4276	Dep	Red/cream limey layer between gas regenerators	
971b	Trench D	4277	Void	Void	
971b	Trench D	4278	Void	Void	
971b	Trench D	4279	Dep	Red pea grit	
971b	Trench D	4280	Str	Concrete support	
971b	Trench D	4281	Str	Sandstone blocks	
971b	Trench D	4282	Str	Sandstone slabs to W of sandstone wall 2	
971b	Trench D	4283	Str	Sandstone wall foundation - **1st Phase Wall 2**	
971b	Trench D	4284	Str	Flat brick surface to W of sandstone wall 2	Machine made, unfrogged r/b
971b	Trench D	4285	Str	S wall of early? puddle base under **Puddle Base A**	Machine made, unfrogged r/b
971b	Trench D	4286	Dep	Clinker deposit within Puddle base A support walls	
971b	Trench D	4287	Dep	Brown silt backfill of [4300]	
971b	Trench D	4288	Dep	Greyish purple grit - made ground phase 1	
971b	Trench D	4289	Dep	Gritty yellow clay - made ground phase 1	
971b	Trench D	4290	Dep	Gritty pale silt - made ground phase 1	
971b	Trench D	4291	Dep	Bluish stony clinker - made ground phase 1	
971b	Trench D	4292	Dep	Black clinker - made ground phase 1	
971b	Trench D	4293	Dep	Pale rubble layer - made ground phase 1	
971b	Trench D	4294	Dep	Orangey rubble layer - made ground phase 1	
971b	Trench D	4295	Dep	White mortar layer - made ground at Puddle base A	
971b	Trench D	4296	Dep	Lower fill within Puddle base A support walls	
971b	Trench D	4297	Dep	Bluish stony layer within Puddle base A support walls	
971b	Trench D	4298	Dep	Mortar/brick rubble layer made ground at Puddle base A	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4299	Dep	Pale rubble layer within Puddle base A support walls	
971b	Trench D	4300	Cut	Repair construction cut for [4281] **1st Phase Wall 2**	
971b	Trench D	4301	Str	S external wall of - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4302	Str	Lattice work in hot air chamber - **Gas Regen Alpha**	Machine made fire brick
971b	Trench D	4303	Str	Fe pipe in [4144]	
971b	Trench D	4304	Dep	Fill of S Brick Culvert and metal plate covers	
971b	Trench D	4305	Dep	Black clinker layer in Puddle Base F	
971b	Trench D	4306	Dep	Slag at neck of Puddle Base F	
971b	Trench D	4307	Str	Brick floor of **Puddle Base F**	Machine made, unfrogged r/b
971b	Trench D	4308	Str	Square bolted support on [4043], N of Puddle Base C	
971b	Trench D	4309	Cut	Construction cut for **Puddle Base C**	
971b	Trench D	4310	Dep	Rough concrete foundation of **Chimney II**	
971b	Trench D	4311	Str	Sandstone foundation for [4046] - part of - **1st Phase Wall 4**	
971b	Trench D	4312	Dep	Rubble beneath [4000] in square sondage	
971b	Trench D	4313	Dep	Pre construct made ground in square sondage	
971b	Trench D	4314	Cut	Pipe construction cut	
971b	Trench D	4315	Dep	Fill of [4314]	
971b	Trench D	4316	Void	Void	
971b	Trench D	4317	Dep	Fill of [4316]	
971b	Trench D	4318	Cut	Construction cut for chimney base [4041]	
971b	Trench D	4319	Cut	NE-SW drain construction cut	
971b	Trench D	4320	Dep	Fill of [4319]	
971b	Trench D	4321	Cut	NW-SE drain construction cut	
971b	Trench D	4322	Dep	Fill of [4321]	
971b	Trench D	4323	Str	Grey sandy mortar above floor of **Puddle Base D**	Machine made, unfrogged r/b

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4324	Dep	Slag in neck of Puddle Base D	
971b	Trench D	4325	Dep	Silt in neck of Puddle Base D	
971b	Trench D	4326	Dep	Rubble in neck of Puddle Base D	
971b	Trench D	4327	Dep	Black clinker deposit under soak-away	
971b	Trench D	4328	Dep	Hard mortar surface in soak-away	
971b	Trench D	4329	Dep	Fill of soak-away	
971b	Trench D	4330	Dep	Brick shelf in soak away	Machine made fire brick
971b	Trench D	4331	Str	Short length of red brick walling under [4082]	Machine made, unfrogged r/b
971b	Trench D	4332	Str	E end wall of **Puddle Base F**	Machine made, frogged r/b
971b	Trench D	4333	Str	Drain structure at E end of **Puddle Base F**	Mixed red & fire brick
971b	Trench D	4334	Dep	Fill within drain [4333]	
971b	Trench D	4335	Str	W arched wall of **N Brick Culvert**	Machine made, unfrogged r/b
971b	Trench D	4336	Str	E arched wall of **N Brick Culvert**	Machine made, unfrogged r/b
971b	Trench D	4337	Dep	Fill between [4335] & [4336]	
971b	Trench D	4338	Str	Brick floor of **Puddle Base F**	Machine made, unfrogged r/b
971b	Trench D	4339	Cut	Extensive truncation for drains @ E of trench	
971b	Trench D	4340	Dep	Mortar layer	
971b	Trench D	4341	Str	Sandstone ledge	
971b	Trench D	4342	Str	Sandstone wall	
971b	Trench D	4343	Dep	Black clinker	
971b	Trench D	4344	Str	Pipe in [4321]	
971b	Trench D	4345	Str	Pipe in [4319]	
971b	Trench D	4346	Void	Void	
971b	Trench D	4347	Cut	Pipe into Y-shape N of Tr. D	
971b	Trench D	4348	Dep	Fill of [4347]	
971b	Trench D	4349	Str	External corner of Y-shape	Machine made, unfrogged r/b
971b	Trench D	4350	Cut	Cut for drainage pipe trench	
971b	Trench D	4351	Dep	Fill of [4350] - material like [4169]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4352	Dep	Upper fill of [4350] - clay	
971b	Trench D	4353	Cut	Construction cut for **S Brick Culvert**	
971b	Trench D	4354	Dep	Clay packing around **S Brick Culvert**	
971b	Trench D	4355	Cut	Cut for drainage pipe trench	
971b	Trench D	4356	Void	Void	
971b	Trench D	4357	Dep	Fill of [4339] - large grey deposit	
971b	Trench D	4358	Dep	Clay fill of [4350]	
971b	Trench D	4359	Str	Possible flue leading to Chimney II (N side)	
971b	Trench D	4360	Str	Drain structure in [4350]	Machine made, unfrogged r/b
971b	Trench D	4361	Dep	Fill of drainage pipe cuts	
971b	Trench D	4362	Str	Metal drainage plate at the rear of **Puddle Base D**	
971b	Trench D	4363	Str	Brick floor of **Puddle Base D**	Machine made, unfrogged r/b
971b	Trench D	4364	Str	Brick flooring of drain linking Puddle Bases B & D	Machine made, unfrogged r/b
971b	Trench D	4365	Cut	Cut of drain linking Puddle Bases B & D	
971b	Trench D	4366	Str	Brick walling beneath **Puddle Base B**	Machine made, unfrogged r/b
971b	Trench D	4367	Str	N Brick manhole wall of drain linking Puddle Bases B & D	Machine made, unfrogged r/b
971b	Trench D	4368	Str	S Brick manhole wall of drain linking Puddle Bases B & D	Machine made, unfrogged r/b
971b	Trench D	4369	Str	E Brick manhole wall of drain linking Puddle Bases B & D	Machine made, unfrogged r/b
971b	Trench D	4370	Str	W Brick manhole wall of drain linking Puddle Bases B & D	Machine made, unfrogged r/b
971b	Trench D	4371	Str	Corroded metal drain cover of drain linking Puddle Bases B & D	
971b	Trench D	4372	Str	Sandstone foundation of N wall of **1st Phase Furnace Room**	
971b	Trench D	4373	Str	Brick surface of **1st Phase Furnace Room**	Machine made fire brick
971b	Trench D	4374	Str	Foundation surface for [4037]	
971b	Trench D	4375	Str	Vaulted roof over **Gas Regen Beta Flue cellar**	Machine made fire brick

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4376	Str	Red brick blocking access door to - **Gas Regen Beta**	Machine made fire brick
971b	Trench D	4377	Str	Sandstone foundation of S wall of **1st Phase Furnace Room**	
971b	Trench D	4378	Str	Structure parallel and abutting [4191]	
971b	Trench D	4379	Dep	Fill between foundations of 1st Phase Furnace	
971b	Trench D	4380	Dep	Fill within [4191] and [4377]	
971b	Trench D	4381	Dep	Purplish brown deposit within Gas Regen Beta flue cellar	
971b	Trench D	4382	Cut	Demolition cut of 1st Phase Furnace Room	
971b	Trench D	4383	Void	Void	
971b	Trench D	4384	Str	Red brick N & W wall of **Gas Regen Beta's flue cellar**	Machine made, unfrogged r/b
971b	Trench D	4385	Void	Void	
971b	Trench D	4386	Str	S U-shaped body of **steam hammer** anvil housing	
971b	Trench D	4387	Str	Sandstone slab machine base of W **steam hammer arm base**	
971b	Trench D	4388	Str	N U-shaped body of **steam hammer** anvil housing	
971b	Trench D	4389	Str	Concrete slab to W cell of steam hammer	
971b	Trench D	4390	Str	Sandstone slabs forming N edge of W **steam hammer arm base**	
971b	Trench D	4391	Str	Sandstone slabs forms W edge of W **steam hammer arm base**	
971b	Trench D	4392	Fill	Fill of W cell of timber lined Str.	
971b	Trench D	4393	Fill	Fill of timber lined Str.	
971b	Trench D	4394	Str	Timber dampener of **steam hammer** anvil	
971b	Trench D	4395	Str	Sandstone slabs forming S edge of E **steam hammer arm base**	
971b	Trench D	4396	Str	Fire brick surface W of steam hammer	Machine made fire brick
971b	Trench D	4397	Dep	Bright red gritty sand - 1st phase made ground S of wall 4	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4398	Str	Metal plates over culvert	
971b	Trench D	4399	Str	Brick walls of culvert under [4398]	Machine made, unfrogged r/b
971b	Trench D	4400	Void	Void	
971b	Trench D	4401	Void	Void	
971b	Trench D	4402	Str	Mortar covered brick floor over Gas Regen Beta flue cellar	Machine made, unfrogged r/b
971b	Trench D	4403	Str	Red brick walling of early column support surround	Machine made, frogged r/b
971b	Trench D	4404	Str	Rubble deposit within column support surround	
971b	Trench D	4405	Str	Sandstone column support	
971b	Trench D	4406	Str	Red brick row	Machine made, frogged r/b
971b	Trench D	4407	Str	NW/SE fire brick wall	
971b	Trench D	4408	Dep	Metalled slag on E steam hammer arm base	
971b	Trench D	4409	Str	Fire brick surface next steam hammer	Machine made fire brick
971b	Trench D	4410	Dep	Clay packing between [4235] and [4068]	
971b	Trench D	4411	Dep	Red (burnt) deposit under firebrick surface, 1st Phase Furnace	
971b	Trench D	4412	Str	Sandstone wall between [4372] and [4078] - **1st Phase Furnace**	
971b	Trench D	4413	Str	Flat red brick floor surface of culvert between walls [4399]	Machine made, unfrogged r/b
971b	Trench D	4414	Void	Void	
971b	Trench D	4415	Dep	Demolition rubble deposit in culvert [4399],[4398]	
971b	Trench D	4416	Dep	Construction cut backfill of [4445]	
971b	Trench D	4417	Cut	Cut for large square drain manhole between puddle bases A – D	
971b	Trench D	4418	Dep	Backfill of cut [4417]	
971b	Trench D	4419	Str	Pyramidal sandstone foundation of **Chimney I**	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4420	Dep	Concreted hammerscale within E steam hammer arm base void	
971b	Trench D	4421	Dep	Deposit above (4420) within E steam hammer arm base void	
971b	Trench D	4422	Cut	Construction cut for [4310]	
971b	Trench D	4423	Dep	Slag & clinker - 1st phase made ground over (4397)	
971b	Trench D	4424	Dep	Clinker deposit under Puddle Base E	
971b	Trench D	4425	Str	Sandstone foundation of **1st Phase Furnace Room**	
971b	Trench D	4426	Void	Void	
971b	Trench D	4427	Dep	Clinker deposit to the North of [4372]	
971b	Trench D	4428	Dep	Clinker deposit to the South of [4372]	
971b	Trench D	4429	Dep	Fill between foundations of 1st Phase Furnace	
971b	Trench D	4430	Dep	Red crushed brick below **Chimney I**	
971b	Trench D	4431	Dep	Black clinker - made ground 1st Phase	
971b	Trench D	4432	Dep	Salmon grit - made ground 1st Phase	
971b	Trench D	4433	Dep	Yellowish brown clay between - made ground 1st Phase	
971b	Trench D	4434	Dep	Salmon grit - made ground 1st Phase	
971b	Trench D	4435	Dep	Yellowish brown clay - made ground 1st Phase	
971b	Trench D	4436	Dep	Black clinker made ground - made ground 1st phase	
971b	Trench D	4437	Dep	Clay made ground - made ground 1st phase	
971b	Trench D	4438	Dep	Black clinker made ground - made ground 1st phase	
971b	Trench D	4439	Dep	Red crushed brick made ground - made ground 1st phase	
971b	Trench D	4440	Dep	Slag and clinker made ground - made ground 1st phase	
971b	Trench D	4441	Dep	Clayey made ground - made ground 1st phase	
971b	Trench D	4442	Dep	Black clinker made ground - made ground 1st phase	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	Trench D	4443	Dep	Clayey made ground - made ground 1st phase	
971b	Trench D	4444	Dep	Brown ashy made ground - made ground 1st phase	
971b	Trench D	4445	Cut	Construction cut **Chimney II**	
971b	Trench D	4446	Dep	Construction cut backfill within [4445]	
971b	Trench D	4447	Dep	Construction cut clinker backfill within [4445]	
971b	Trench D	4448	Dep	Black clinker - 1st phase made ground at site E	
971b	Trench D	4449	Dep	Deposit overlying - made ground 1st Phase	
971b	Trench D	4450	Dep	Deposit within puddle base drain man-hole	
971b	Trench D	4451	Dep	Post demo backfill between modern walls [4211 & 4214]	
971b	Trench D	4452	Dep	Concrete slabs & rubble overburden	
971b	W.Brief	5000	Str	Remnant drainage wall	
971b	W.Brief	5001	Str	Remnant drainage wall	
971b	W.Brief	5002	Cut	Cut of cellarage (disturbed)	
971b	W.Brief	5003	Dep	Backfill of cellarage	
971b	W.Brief	5004	Str	Manhole/drain	
971b	W.Brief	5005	Dep	Backfill of manhole/drain	
971b	W.Brief	5006	Cut	Cut for drain pipe	
971b	W.Brief	5007	Str/Fill	Modern drain pipe and fill	
971b	W.Brief	5008	Dep	Levelling layer/backfill	
971b	W.Brief	5009	Str	East wall of building	
971b	S & R	6000	Str	East - west sandstone wall	
971b	S & R	6001	Str	North - south return of [6000]	
971b	S & R	6002	Str	East - west sandstone block	
971b	S & R	6003	Str	North - south sandstone blocks butting east of [6002]	
971b	S & R	6004	Str	East - west sandstone blocks butting south of [6003]	
971b	S & R	6005	Str	Sandstone block between [6001] and [6004]	
971b	S & R	6006	Str	Firebrick wall south of [6004]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6007	Str	North - south aligned sandstone block, west of [6001]	
971b	S & R	6008	Str	East - west aligned sandstone block, butts north of [6007]	
971b	S & R	6009	Str	North - south aligned sandstone block, butts west of [6008]	
971b	S & R	6010	Str	Firebrick surface over [6009]	
971b	S & R	6011	Str	North - south aligned sandstone blocks south west of [6010]	
971b	S & R	6012	Str	North - south aligned sandstone blocks, south of [6011]	
971b	S & R	6013	Str	Square arrangement of sandstone blocks, south of [6006]	
971b	S & R	6014	Str	East - west lime mortared red brick wall	
971b	S & R	6015	Str	North - south alignment of sandstone blocks, east of [6014]	
971b	S & R	6016	Str	East - west alignment of sandstone blocks, butting centre of [6015]	
971b	S & R	6017	Str	Sandstone blocks, possible continuation of [6016]	
971b	S & R	6018	Str	North - south aligned sandstone block, east of [6015]	
971b	S & R	6019	Str	North - south aligned sandstone block, parallel to [6018]	
971b	S & R	6020	Str	East - west alignment of sandstone blocks, south of [6018] and [6019]	
971b	S & R	6021	Str	North - south alignment of sandstone blocks, butts [6020]	
971b	S & R	6022	Str	North - south sandstone wall south of [6020]	
971b	S & R	6023	Str	Square sandstone block, east of [6022]	
971b	S & R	6024	Str	Square sandstone block, east of [6023]	
971b	S & R	6025	Str	Single sandstone block at far east of strip and record (area 1)	
971b	S & R	6026	Str	East - west red brick wall, south of [6025]	
971b	S & R	6027	Str	Brick surface with hammerscale above	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6028	Str	Single sandstone block, west of [6026]	
971b	S & R	6029	Str	Two sandstone blocks, north of [6028]	
971b	S & R	6030	Str	L-shaped block, west of [6029]	
971b	S & R	6031	Str	East - west sandstone block, butts east of [6021]	
971b	S & R	6032	Str	L-shaped sandstone block, north of [6030]	
971b	S & R	6033	Str	East - west sandstone block, east of [6032]	
971b	S & R	6034	Str	L-shaped sandstone block, east of [6033]	
971b	S & R	6035	Str	North - south sandstone block, butts west of [6020]	
971b	S & R	6036	Str	East - west sandstone blocks, parallel and south of [6020]	
971b	S & R	6037	Str	Chimney to the west of [6036]	
971b	S & R	6038	Str	Large sandstone block, west of [6014]	
971b	S & R	6039	Str	Large sandstone block, west of [6038]	
971b	S & R	6040	Str	Single sandstone block, south of [6039]	
971b	S & R	6041	Str	Large sandstone block, west of [6040]	
971b	S & R	6042	Str	Large sandstone block, west of [6041]	
971b	S & R	6043	Str	Sandstone block, west of [6042]	
971b	S & R	6044	Str	Wall to south, on gas regenerator chamber [6045]	
971b	S & R	6045	Str	South wall of hot air chamber (south)	
971b	S & R	6046	Str	Checkerboard bricks of hot air chamber	
971b	S & R	6047	Str	Wall separating hot and cold chambers (south)	
971b	S & R	6048	Str	Checkerboard bricks of cold air chamber (south)	
971b	S & R	6049	Str	Wall separating the two cold air chambers	
971b	S & R	6050	Str	Checkerboard bricks of (northern) cold air chamber	
971b	S & R	6051	Str	Wall separating cold and hot air chambers (north)	
971b	S & R	6052	Str	Checkerboard bricks of northern hot air chamber	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6053	Str	North wall of gas regenerator (south)	
971b	S & R	6054	Str	Southern wall of north gas regenerator	
971b	S & R	6055	Str	Checkerboard bricks of southern hot air chamber	
971b	S & R	6056	Str	Arched structure forming south and north wall of cold air chamber	
971b	S & R	6057	Str	Checkerboard bricks of cold air chamber	
971b	S & R	6058	Str	Brick culvert	
971b	S & R	6059	Str	Chimney at south of [6058]	
971b	S & R	6060	Str	Square brick structure	
971b	S & R	6061	Str	Layered section (north facing) through hammer base	
971b	S & R	6062	Str	Concrete structure with square centre, north extent of trench	
971b	S & R	6063	Str	Concrete structure with square centre, east of [6062]	
971b	S & R	6064	Str	North - south red brick wall between [6062] and [6063]	
971b	S & R	6065	Str	L-shaped concrete base under east side of [6062]	
971b	S & R	6066	Str	East- west return of [6065], under west side of [6063]	
971b	S & R	6067	Str	Sandstone base, south of [6066]	
971b	S & R	6068	Str	Sandstone machine base with six pins, east of [6067]	
971b	S & R	6069	Str	Firebrick structure, east of [6068]	
971b	S & R	6070	Str	Red brick circular chimney, south of [6068]	
971b	S & R	6071	Str	Concrete machine base truncation, west of [6070]	
971b	S & R	6072	Str	Concrete machine base truncation, east of [6070]	
971b	S & R	6073	Str	Concrete machine base, west of [6071]	
971b	S & R	6074	Str	One skin red brick wall between [6071] and [6073]	
971b	S & R	6075	Str	Two skin red brick wall between [6071] and [6073]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6076	Str	East - west drain with cast iron cap, south of [6075]	
971b	S & R	6077	Str	Culvert south of [6076]	
971b	S & R	6078	Str	Lime mortared, red brick wall south of [6077]	
971b	S & R	6079	Str	Lime mortared, red brick wall west of [6077]	
971b	S & R	6080	Str	Square red brick structure at west end of [6079]	
971b	S & R	6081	Str	Square concrete machine base, south of [6071]	
971b	S & R	6082	Str	Square concrete machine base, south of [6072]	
971b	S & R	6083	Str	Sandstone block foundation for roof support, east of [6077]	
971b	S & R	6084	Str	Concrete footing for machine base to west of [6079]	
971b	S & R	6085	Str	Concrete base, east of [6072]	
971b	S & R	6086	Str	Red brick linear, south of [6082] and [6085]	
971b	S & R	6087	Str	Modern concrete covered drain, south of [6086]	
971b	S & R	6088	Str	Red brick structure, north of [6072] and east of [6069]	
971b	S & R	6089	Str	Isolated sandstone flag, west of [6084]	
971b	S & R	6090	Str	Red brick and concrete tank, west of [6073]	
971b	S & R	6091	Str	Red brick and concrete structure below and north of [6072]	
971b	S & R	6092	Str	Base for roof support between [6086] and [6087]	
971b	S & R	6093	Str	Concrete base with central recess	
971b	S & R	6094	Str	Outer circular red brick structure, associated with [6094]	
971b	S & R	6095	Str	Inner circular red brick structure, associated with [6094]	
971b	S & R	6096	Dep	Upper demolition fill between [6094] and [6095]	
971b	S & R	6097	Dep	Lower clayey fill below (6096)	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6098	Dep	Flat concrete surface below (6097)	
971b	S & R	6099	Str	Large north - south sandstone wall, parallel to [6181]	
971b	S & R	6100	Str	Sandstone floor incorporating [6101]	
971b	S & R	6101	Str	Raised hexagonal structure set onto [6108]	
971b	S & R	6102	Str	Rectangular structure of large sandstone blocks	
971b	S & R	6103	Str	Structure directly west of [6101]	
971b	S & R	6104	Str	Machine base adjoining [6105]	
971b	S & R	6105	Str	Sand stone crane base	
971b	S & R	6106	Str	Rectangular sandstone structure, butts west of [6110], containing [6107]	
971b	S & R	6107	Str	Brick surrounded concrete slope within [6106]	
971b	S & R	6108	Str	Firebrick structure with two metal plates and four pins	
971b	S & R	6109	Str	Square red brick structure containing cast iron pipe	
971b	S & R	6110	Str	Symetrical sandstone machine bases aligned north - south	
971b	S & R	6111	Str	Red brick walling forming a viod between [6105] and [6110]	
971b	S & R	6112	Str	North - south aligned sandstone wall	
971b	S & R	6113	Str	Remnant sandstone wall (south east corner)	
971b	S & R	6114	Str	Cast iron pipe	
971b	S & R	6115	Str	Later addition to [6110], contemporary with [6118]	
971b	S & R	6116	Str	East - west wall linking parallel sides of [6110]	
971b	S & R	6117	Str	Concrete addition/truncation (?) [6110]	
971b	S & R	6118	Str	Later addition to [6110], contemporary with [6115]	
971b	S & R	6119	Str	Part of engine/machine base	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6120	Str	Sandstone block, recessed for engine/machine mounting	
971b	S & R	6121	Str	Remnant of east - west aligned red brick wall	
971b	S & R	6122	Str	Later northern factory wall, associated with [6123]	
971b	S & R	6123	Str	East - west wall and pillar/column base	
971b	S & R	6124	Str	East - west structure, northern limit of area 3	
971b	S & R	6125	Str	Structure butting west side of [6126]	
971b	S & R	6126	Str	Sandstone machine base, east of [6125]	
971b	S & R	6127	Str	Large structure, north west corner of area 3	
971b	S & R	6128	Str	Concrete machine base	
971b	S & R	6129	Str	Red brick wall, butts [6094]	
971b	S & R	6130	Str	Red brick edged sandstone machine base	
971b	S & R	6131	Str	North-south aligned cast iron pipe, truncates upper extent of [6132]	
971b	S & R	6132	Str	Circular red brick structure	
971b	S & R	6133	Str	Heavily truncated east - west brick wall remnant	
971b	S & R	6134	Str	Possible sandstone pillar/column support	
971b	S & R	6135	Str	Brick lined metal pipe culvert	
971b	S & R	6136	Str	Sandstone base and cast iron column	
971b	S & R	6137	Str	North west corner of truncated brick structure	
971b	S & R	6138	Str	Square brick structure, possibly drain cover/pipe in/out-let	
971b	S & R	6139	Str	East - west aligned sandstone wall with recessed 'alcove'	
971b	S & R	6140	Str	Brick lining within 'alcove' of [6139]	
971b	S & R	6141	Str	East - west aligned sandstone wall/foundations	
971b	S & R	6142	Str	Probable brick column base	
971b	S & R	6143	Str	Wall division	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6144	Str	Rectangular brick structure with added partitioning wall	
971b	S & R	6145	Str	Rectangular walled sandstone building foundations	
971b	S & R	6146	Str	Sandstone and brick surface/walling remnant	
971b	S & R	6147	Str	Column base and column	
971b	S & R	6148	Str	Remnant of rectangular sandstone building	
971b	S & R	6149	Str	Sandstone engine/machine base	
971b	S & R	6150	Str	Later phase engine/machine base	
971b	S & R	6151	Str	Brick puddle base	
971b	S & R	6152	Str	Brick puddle base	
971b	S & R	6153	Str	Modern pipe trench	
971b	S & R	6154	Str	Red brick wall	
971b	S & R	6155	Str	Red brick wall with buttresses/column bases	
971b	S & R	6156	Str	Remnant red brick wall	
971b	S & R	6157	Str	Heat damaged sandstone and firebrick surface	
971b	S & R	6158	Str	Puddle furnace base	
971b	S & R	6159	Str	Puddle furnace base	
971b	S & R	6160	Str	Red brick structure with internal squared cells	
971b	S & R	6161	Str	Puddle furnace base (not on 1923 plan)	
971b	S & R	6162	Str	Possible machinery base for puddlers	
971b	S & R	6163	Str	Puddle furnace base (re-build?)	
971b	S & R	6164	Str	Service access to [6163]	
971b	S & R	6165	Str	Sandstone and red brick wall, east end of area 2	
971b	S & R	6166	Str	Red brick wall, possibly associated with [6165]	
971b	S & R	6167	Str	Concrete foundation for [6168]	
971b	S & R	6168	Str	East - west red brick wall across south end of area 2	
971b	S & R	6169	Str	Dividing wall between puddle bases [6158] and [6159]	
971b	S & R	6170	Str	Red brick wall/external west wall of puddle base [6159]	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6171	Str	Handmade red brick wall parallel to [6168]	
971b	S & R	6172	Dep	Waste deposit filling [6163]	
971b	S & R	6173	Str	Brick and sandstone column base	
971b	S & R	6174	Str	North - south aligned remnant red brick wall	
971b	S & R	6175	Str	Sandstone wall associated with [6127]	
971b	S & R	6176	Dep	Black slag and silty fill within [6160]	
971b	S & R	6177	Dep	Black clinker and silty fill within [6160]	
971b	S & R	6178	Str	Flat red brick surface above [6160]	
971b	S & R	6179	Str	East - west aligned brick wall	
971b	S & R	6180	Str	Back end of possible puddle base	
971b	S & R	6181	Str	Wall parallel to [6099]	
971b	S & R	6182	Str	L-shaped brick culvert/flue	
971b	S & R	6183	Str	Square shaped brick structure	
971b	S & R	6184	Str	Sandstone block with pins	
971b	S & R	6185	Str	Sandstone block	
971b	S & R	6186	Str	Concrete foundation, truncates [6187] and [6188]	
971b	S & R	6187	Str	North wall of probable puddle base, associated with [6188]	
971b	S & R	6188	Str	Puddle furnace base (neck end), associated with [6187]	
971b	S & R	6189	Str	Sandstone hearth and brick chimney	
971b	S & R	6190	Str	Truncated brick surface	
971b	S & R	6191	Str	Probable gas regenerator, south of Trench A	
971b	S & R	6192	Str	Modern cellar wall with brick demolition rubble in-fill	
971b	S & R	6193	Str	Sandstone blocks, south east of [6036]	
971b	S & R	6194	Dep	Natural yellow silty clay	
971b	S & R	6195	Str	North - south continuation of [6023]	
971b	S & R	6196	Str	Machine bases associated with rolling mill structures	
971b	S & R	6197	Str	Sandstone, butts [6198] and [6199] - north to south	

Site code	Site sub-division	Context number	Context type	Description	Brick Type (r/b = red brick)
971b	S & R	6198	Str	Sandstone, butts [6197] and [6024] - east to west	
971b	S & R	6199	Str	Red brick wall, facing evaluation Trench C structures	
971b	S & R	6200	Str	East - west firebrick wall	

APPENDIX 2: COPY OF THE SPECIFICATION

WEST YORKSHIRE ARCHAEOLOGY ADVISORY SERVICE:

SPECIFICATION FOR AN ARCHAEOLOGICAL EXCAVATION AT MONK BRIDGE IRONWORKS (DONCASTER'S), WHITEHALL ROAD, LEEDS

Specification prepared on behalf of Leeds City Council at the request of Rob Kinchin-Smith of RPS Planning and Environment

1. Summary

1.1 A limited amount of archaeological work consisting of open-area excavation, followed by a targeted watching brief during the removal of large-scale obstructions and site decontamination, is proposed to mitigate the impact of development at the above site.

1.2 This specification deals with the excavation and the preparation of an assessment report on the results of the fieldwork. The assessment report will establish whether further analysis and the preparation of a publication report is required. Any work arising from the results of the excavation and the assessment report will be additional to this specification.

1.3 This specification has been prepared by the curatorial branch of the West Yorkshire Archaeology Advisory Service (WYAAS), the holders of the West Yorkshire Sites and Monuments Record.

NOTE: The requirements detailed in paragraphs 6.1, 6.2, 6.3, 6.4, 6.5, 7.5, 7.6 and 10.1 are to be carried out by the archaeological contractor **prior** to the commencement of fieldwork.

2. Site Location & Description (Fig.1)

Grid Reference: SE 2904 3308 (centred)

2.1 The development site lies on the northwest side of Whitehall Road, in west Leeds. The buildings which formerly stood on the site (with the exception of the electricity substation) have been cleared following an appropriate level of archaeological and architectural recording.

2.2 The site has been partially excavated in the course of commencement of decontamination/obstruction clearance (now temporarily halted). The area of archaeological interest is interspersed with a number of very deep holes and with several large piles of excavation spoil and demolition debris/crush.

2.3 The drift geology of the area is alluvium overlying lower coal measures.

3. Planning Background

3.1 In response to an application for outline planning consent (ref. 06/02880/OT/C) made to Leeds City Council by the owner, the Planning Authority were advised by WYAAS that there was reason to believe that important archaeological remains may be affected by the proposed development.

3.2 Partial stripping and cleaning of the site by ARCUS in October 2006 revealed that significant archaeological remains are present in several parts of the site. These remains will be destroyed by the development of the site and further archaeological

excavation and recording works are required to mitigate this impact.

3.3 This specification has been prepared by WYAAS, at the request of Rob Kinchin-Smith of RPS Planning and Environment (acting on behalf of the developer), to detail what is required and to allow an archaeological contractor to provide a quotation. This work is being undertaken to fulfil the terms of an archaeological condition which it is expected will be attached to any Planning Consent granted.

4. Archaeological Interest

4.1 Monk Bridge Forge was established by James Whitham in 1851 for the production of wrought iron. The site was acquired very shortly afterward by the Kitson family (prominent Leeds locomotive engineers) for the production of forged components, including axles and locomotive tyres, to supply their other works. The earliest substantive manufacturing elements on the site appear to have consisted of puddling furnace sheds and a shed that may have been at least partly employed for the production of crucible steel, both probably extant from the 1850s. A rolling mill between the two was extant by the early 1880s and probably existed in some form on the site at an earlier date.

4.2 Substantial development and alteration took place on the site during the course of its ownership by the Kitsons, including the transfer of steel production to land on the south side of Whitehall Road from the mid-1860s. Further development, including substantial demolition and rebuilding, took place after the site was acquired by Daniel Doncasters of Sheffield, particularly in the area of the rolling and puddling mills.

4.3.1 It seemed probable that little material of archaeological interest would survive from the early years of the site; however, targeted stripping subsequent to the demolition of the standing structures on site has revealed relatively well-preserved structures and stratigraphy which may provide further information on the structures and processes employed at Monk Bridge between the 1850s and the 1890s. Features of particular interest have been exposed in three of the five areas targeted for stripping in October 2006 (see attached ARCUS Ill. 1 ‘ Trench locations’):

4.3.2 Trench A contains the substructure of a feature which appears to be associated with the item tentatively identified by Structural Perspectives as a crucible furnace on the plan of 1923. Although upon initial examination the material revealed by the initial stripping bears little resemblance to the foundations of a crucible furnace, the feature survives in good condition and was clearly designed to perform a specific function; in addition, a substantial portion appears (from analysis of the materials) to be of mid-19th century date. The feature is therefore considered to warrant further investigation to determine as far as possible its function and sequence of development, and its functional relationship to other features in the near vicinity (such as the crane bases that have been identified immediately adjacent).

4.3.3 Trench B3 contains the remains of a mid-19th century engine base and the remains of what appears to be a soak furnace of early 20th century date. The engine base is the best-preserved of those so far encountered on the site, and appears to contain structural elements sufficient to provide some information on the size and form of the engine it supported. The soak furnace is particularly well-preserved and (although very common at the beginning of the 20th century), extant or excavated examples of this type of installation do not survive well. This area is therefore considered to warrant further investigation to document as far as possible the form, function and sequence of development of these features.

4.3.4 Trench D contains the surprisingly well-preserved substructures of two groups of four puddling furnaces each, which occupied this area from the mid-19th century. Although the furnace foundations in the western half of the trench appear to have

been badly disrupted by building work in the 1950s/60s, the group in the eastern half of the trench appears to comprise the relatively intact remains of at least three of the four furnaces, with associated features including chimney base. The interest of this group is enhanced by the fact that the chimneys at this end of the site were not altered during the documented improvements of the 1880s; it is therefore more likely to demonstrate the original conformation of the furnaces. The easterly group of furnace bases is considered to warrant further investigation to document as far as possible the form, function and sequence of development of these features.

4.3.5 In addition to these specifically targeted features, the site is considered to warrant a watching brief within the surviving footprints of the 19th century buildings (as identified in Fig 36 of Structural Perspectives, 2004, *Archaeological Desktop Assessment of the Monkbridge Ironworks*) to identify the size, orientation, and general character of any 19th century engine bases, hammer bases and rolling mill bases which may be identified for removal during the course of site clearance.

5. Aims of the Excavations

5.1 The objective of the project is to fully record, analyse and report all archaeological remains within the areas of interest ('preservation by record') prior to their destruction during the development of the site.

5.2 The specific aims are:

- to characterize and analyze a small group of features associated with heating and handling of metals on the site, and (as far as possible) to place them in context with regard to contemporary features within the area of the ironworks.
- to locate and to characterize the larger features associated with metal handling and working on this site

6. General Instructions

6.1 Health and Safety

6.1.1 The archaeologist on site will naturally operate with due regard for Health and Safety regulations. Regard should also be taken of any reasonable additional constraints that the developer or other contractors may impose. The excavation may require the preparation of a Risk Assessment of the site in accordance with the Health and Safety at Work Regulations. WYAAS and its officers cannot be held responsible for any accidents or injuries that may occur to outside contractors while attempting to conform to this specification. Any Health and Safety issues which may hinder compliance with this specification should be discussed with WYAAS at the earliest possible opportunity (see section 13.2).

6.2 Confirmation of Adherence to Specification

6.2.1 Prior to the commencement of *any work,* the archaeological contractor must confirm adherence to this specification in writing to WYAAS, or state (with reasons) any proposals to vary the specification. Should the contractor wish to vary the specification, then written confirmation of the agreement of WYAAS to any variations is required prior to work commencing. Unauthorised variations are made at the sole risk of the contractor. **Modifications presented in the form of a re-written specification/project design will not be considered by WYAAS.** Any technical queries arising from the specification detailed below should be addressed to WYAAS without delay.

6.3 Confirmation of Timetable and Contractors' Qualifications

6.3.1 Prior to the commencement of *any work*, the archaeological contractor **must**

provide WYAAS **in writing** with:

- a projected timetable for the site work;
- details of the staff structure and numbers;
- names and *CVs* of key project members (the project manager, site supervisor, any proposed specialists, sub-contractors *etc.*).

6.3.2 All project staff provided by the archaeological contractor must be suitably qualified and experienced for their roles. The timetable should be adequate to allow the work to be undertaken to the appropriate professional standard, subject to the ultimate judgement of WYAAS.

6.4 Notification

6.4.1 The excavations will be monitored as necessary and practicable by WYAAS in its role as curator of the county's archaeology. WYAAS should be provided with **as much notice as possible in writing** (and certainly not less than one week) of the intention to start work. A copy of the archaeological contractor's risk assessment of the site should accompany the notification.

6.4.2 The museums officer named in paragraph 10.1 should be notified in writing of the commencement of fieldwork at the same time as WYAAS.

6.4.3 As a courtesy, English Heritage's Regional Science Adviser, Andy Hammon should also be notified of the intention to commence fieldwork. (Tel.: 01904 601983; email: andy.hammon@english-heritage.org.uk).

6.5 Documentary Research

6.5.1 An overview of the archaeological/historical background of the site and environs is provided by the reports on the site previously prepared by Structural Perspectives and by RPS Planning and Environment, and by work done to date on the site by ARCUS. Key site staff are expected to have familiarised themselves with this material. In addition to providing a knowledge base for the work in hand, the results of the earlier assessments and of the Building Recording by ARCUS (report in preparation) may be incorporated into the contractor's report where they are considered to contribute to that report, but any extraneous material should be omitted.

6.6 Location of Services, etc.

6.6.1 The archaeological contractor will be responsible for locating any drainage pipes, service pipes, cables etc which may cross any of the trench lines, and for taking the necessary measures to avoid disturbing such services.

7. Fieldwork Methodology - Full Excavation

7.1 Trench Size and Location

7.1.1 The targeted excavation work will involve the excavation of three areas totalling 900m^2, as outlined in red in attached plans ARCUS Ills. 2, 4 and 6. The contractor should also make provision for a contingency area of up to 200m^2. The use of the contingency will depend upon the results obtained during the initial excavations and will be implemented at the discretion of WYAAS. The decision to invoke all or part of the contingency area will be issued in writing, if necessary in retrospect after site discussions.

7.1.2 The open-area excavation trenches should be located as shown on ARCUS Ill. 1 ' Trench locations'.

	Area (m^2)	Rationale
Trench A	360	Investigate/analyse/record chambered feature and associated cranes/fuel feeds
Trench B3	350	Analyse/record engine base and soak furnace
Trench D	180	Analyse/record puddling furnaces and associated features

Total excavation area: **900m^2**

Contingency allowance: **up to 200m^2**

7.2 Method of Excavation

7.2.1 Where the overburden has yet to be removed, the excavation areas may be opened using an appropriate machine fitted with a wide toothless ditching bucket. The topsoil and recent overburden should be removed down to the first significant archaeological horizon in successive level spits of maximum 0.2m thickness. **Under no circumstances should the machine be used to cut arbitrary trenches down to natural deposits.** All machine work must be carried out under direct archaeological supervision and the machine halted if significant archaeological deposits are encountered. The top of the first significant archaeological horizon may be exposed by the machine, but must then be cleaned by hand and inspected for features. Excavation should then continue manually. Mass concrete may be removed by machine pecking, where this is considered unlikely to cause appreciable damage to any underlying remains. Where it is considered that this approach is likely to cause damage, or where reasonable attempts to remove the concrete have led the contractor to conclude that the concrete constitutes a substantial intrusion rather than a discrete layer, the views of the WYAAS should be sought before proceeding.

7.2.2 All archaeological remains will be hand excavated in an archaeologically controlled and stratigraphic manner sufficient to meet the aims and objectives of the project. The excavation will record the **complete** stratigraphic sequence, down to naturally occurring deposits and will investigate and record **all** inter-relationships between features. The following excavation strategy will be employed:

- Deposits will be planned both at their first visible and their fullest extent. All stratigraphic relationships will be fully explored and documented, if necessary by means of half-sections or quadrants.
- Linear and discrete features: all stake-holes, post-holes, pits, hearth bases, and other structural/industrial features will be 50% excavated in the first instance, recorded in section, and then fully excavated. All intersections will be fully investigated to determine the relationship(s) between the component features.
- Built structures: walls, floors, machine- and crane bases etc will be excavated sufficient to establish their form, phasing, and construction techniques. The feature(s) will then be fully excavated. All intersections will be investigated to determine the relationship(s) between the component features.

If features are encountered which the archaeological contractor considers to be too massive to be excavated by hand using the appropriate tools (mattock, crowbar, etc.), this should be drawn to the attention of the WY Archaeology Advisory Service immediately. The controlled use of a mechanical excavator may in principle be used to excavate/partially remove/test the following types of deposit once appropriate records have been made, but the written agreement of the WYAAS (which may be issued in retrospect after discussions on site) must be sought in each instance in advance of work commencing:

- extensive deposits of made ground or levelling layers
- extensive deposits of less sensitive material, such as fuel ash waste
- compacted deposits which can not be removed by hand or with hand tools
- any deposits identified as contaminated
- Areas of homogenous deposits which do not appear to have particular archaeological sensitivity (e.g. brick rubble, made ground)
- concrete or other substantial intrusions (e.g. machine bases etc)

Large objects (e.g. worked stone) that can not be lifted by one person and homogeneous stretches of brick wall may be removed by machine without specific agreement of the WY Archaeology Advisory Service. However, this method must not be used on brick walls where careful dismantling is likely to reveal further features or archaeological information (e.g. concealed flues; rebuilding).

7.2.3 All finds are to be recorded by context. Individually significant finds ("small finds") are to be recorded three dimensionally and identified using a sequence of unique numbers. The presence and nature of late 20th century material should be noted (quantified and summarily described) but finds of this date need not be retained for processing. Finds judged to be of 18th, 19th and early 20th century date or earlier should be retained.

7.2.4 Samples for environmental analysis and scientific dating should be taken if suitable material is encountered during the excavation. Provision should also be made for specialist sampling if appropriate (soil profiles, archaeomagnetic dating, dendrochrology etc.) (Also see paragraph 7.5.)

7.3 Method of Recording

7.3.1 The trenches are to be recorded according to the normal principles of stratigraphic excavation. The stratigraphy of each area is to be recorded, even when no archaeological deposits have been identified.

7.3.2 Section drawings (at a minimum scale of 1:20) must include heights A.O.D. Plans (at a minimum scale of 1:50) must include O.D. spot heights for all principal strata and any features. At least one section of each trench edge, showing a representative and complete sequence of deposits from the modern ground surface to the natural geology, will be drawn.

7.3.3 The actual areas of excavation and all archaeological (and possibly archaeological) features should be accurately located on a site plan and recorded by photographs, scale drawings and written descriptions sufficient to permit the preparation of a detailed archive and report on the material. The trench locations, as excavated, will be accurately surveyed, tied into the O.S. National Grid and located on an up-to-date 1:1250 O.S. map base.

7.4 Use of Metal Detectors

7.4.1 In principle, spoil heaps are to be scanned for non-ferrous metal artefacts using a metal detector capable of making this discrimination, operated by an experienced metal detector user (if necessary, operating under the supervision of the contracting archaeologist). In practice, the suitability of this technique for scanning all spoil heaps should be tested in the field. It is likely that some deposits will contain a high proportion of ferrous material, rendering the technique incapable of discriminating individual artefacts from general iron-working waste. In these instances, a sampling programme will be employed to retrieve archaeologically relevant artefacts. Suitable deposits will be scanned with the metal detector at intervals; objects retrieved by this method will be recorded as unstratified.

7.4.2 If a non-professional archaeologist is to be used to carry out the metal-detecting, a formal agreement of their position as a sub-contractor working under direction must be agreed in advance of their use on site. This formal agreement will apply whether they are paid or not. To avoid financial claims under the Treasure Act a suggested wording for this formal agreement with the metal detectorist is: "In the process of working on the archaeological investigation at [*location of site*] between the dates of [*insert dates*], [*name of person contributing to project*] is working under direction or permission of [*name of archaeological organisation*] and hereby waives all rights to rewards for objects discovered that could otherwise be payable under the Treasure Act 1996."

7.5 Metallurgical Sampling Strategy

7.5.1 Appropriate deposits must be sampled for retrieval and assessment of the preservation conditions and potential for analysis of all metallurgical remains and residues. A sampling strategy must be agreed with a recognised archaeometallurgist and with the English Heritage Regional Science Advisor (tel. 01904 601901). Prior to the commencement of work on site, the sampling strategy is to be submitted in writing for the written agreement of the WYArchaeology Advisory Service. Provision should be made for the appropriate specialist(s) to visit the site and discuss and amend the sampling strategy, if necessary, during the course of work on site. Any proposed amendments to the sampling strategy will also require the written agreement of the WYArchaeology Advisory Service.

7.6 Conservation Strategy

7.6.1 A conservation strategy must be developed in collaboration with a recognised laboratory. All finds must be assessed in order to recover information that will contribute to an understanding of their deterioration and hence preservation potential, as well as identifying potential for further investigation. Furthermore, all finds must be stabilised and packaged in accordance with the requirements of the receiving museum. As a guiding principle, only artefacts of a “displayable” quality would warrant full conservation, but metalwork and coinage from stratified contexts would be expected to be x-rayed if necessary, and conservation costs should also be included as a contingency.

7.7 Human Remains

7.7.1 Any human remains that are discovered must initially be left *in-situ*, covered and protected. WYAAS will be notified at the earliest opportunity. If removal is necessary the remains must be excavated archaeologically in accordance with the *Guidance for Best Practice for Treatment of Human Remains Excavated from Christian Burial Grounds in England* published by English Heritage (2005), a valid Department of Constitutional Affairs licence and any local environmental health regulations.

7.8 Treasure Act

7.8.1 The terms of the Treasure Act 1996 must be followed with regard to any finds that might fall within its purview. Any finds must be removed to a safe place and reported to the local coroner as required by the procedures as laid down in the “Code of Practice”. Where removal cannot be effected on the same working day as the discovery, suitable security measures must be taken to protect the finds from theft.

7.9 Unexpectedly Significant or Complex Discoveries

7.9.1 Should there be unexpectedly significant or complex discoveries made that warrant, in the professional judgement of the archaeologist on site, more detailed recording than is appropriate within the terms of this specification, then the

archaeological contractor should urgently contact WYAAS with the relevant information to enable them to resolve the matter with the developer.

8. Fieldwork Methodology - Watching Brief

8.1 A watching brief should be maintained during the course of initial site clearance within the footprint of the 19th century buildings on the site. It is accepted by the WY Archaeology Advisory Service that some areas of the 19th century footprint have been substantially disrupted by the initial site clearance earlier in the year, and these areas may naturally be excluded from the watching brief. The watching brief is intended to locate and rapidly record the size, orientation, and general character of any **large** 19th century features such as engine bases, hammer bases and rolling mill bases which may be identified for removal during the course of site clearance. It is not expected that the remains of more delicate or ephemeral features should be located or recorded by this method.

8.2 Where a base is located, the following should be noted and recorded by normal drawn and photographic means:

- position and orientation relative to OS grid
- overall plan
- number and position of any **diagnostic** features such as holding-down bolts or machine-related wear (incidental features such as dressing marks or lewis holes should be discounted for purposes of this record),

It is expected that archaeological recording should take place alongside the required re-measurement of obstruction prior to removal by the principal contractor. The archaeological contractor should also attempt to make a photographic record of the depth and belowground extent of any bases during their removal. However, it is accepted that Health and Safety considerations may hinder such attempts.

9. Monitoring

9.1 The project will be monitored as necessary and practicable by WYAAS, in its role as curator of the county's archaeology and advisor to the local Planning Authority. WYAAS's representative will be afforded access to the site at any reasonable time. It is usual practice that the visit is arranged in advance, but this is not always feasible.

9.2 WYAAS's representative will be provided with a site tour and an overview of the site by the senior archaeologist present and should be afforded the opportunity to view all trenches, any finds made that are still on site, and any records not in immediate use. It is anticipated that the records of an exemplar context that has previously been fully recorded will be examined. Any observed deficiencies during the site visit are to be made good to the satisfaction of WYAAS's representative, by the next agreed site meeting. Access is also to be afforded at any reasonable time to English Heritage's Regional Archaeological Scientific Advisor.

10. Archive Deposition

10.1 Before commencing any fieldwork, the archaeological contractor must determine the requirements for the deposition of the excavation archive. Leeds Museums and Galleries do not currently accept archives resulting from archaeological fieldwork and discussions are continuing as to the most appropriate location for the excavation archive. In this instance WYAAS will take the archive but the requirements of the Leeds Museums and Galleries are to be adhered to (see Appendix 1).

10.2 The deposition of the archive must be accompanied by a storage fee, currently £113 per standard box, payable to West Yorkshire Joint Services. The contractor will be charged the fee current at the time of deposition.

10.3 It is the responsibility of the archaeological contractor to endeavour to obtain

consent of the landowner, in writing, to the deposition of finds with a public body, initially WYAAS, but eventually it is hoped, with Leeds City Museums.

10.4 It is the responsibility of the archaeological contractor to meet Leeds Museums' requirements with regard to the preparation of fieldwork archives for deposition (see Appendix 1).

11. Post-excavation Assessment and Reporting

11.1 Artefacts, Samples and Dating

11.1.1 Upon completion of fieldwork all finds shall be cleaned, identified, marked (if appropriate) and properly packed and stored in accordance with the requirements of national guidelines. Metalwork will be x-rayed (as per paragraph 7.6) and assessed by a conservator. Any samples taken shall be processed appropriately.

11.1.2 All artefacts will be assessed by a qualified and experienced specialist. Assessment should be generally based on MAP2 but should include:

- preparation of a descriptive catalogue;
- dating (where possible);
- an assessment of the significance of the assemblage;
- an assessment of the potential for further analysis to contribute to the interpretation of the archaeology of this site;
- an assessment of the potential for further analysis to contribute to artefact studies;
- recommendations for additional artefact illustration/photography;
- an assessment of the condition of the assemblage and recommendations for conservation, retention/discard and archiving.

11.1.3 All environmental material will be assessed by a qualified and experienced specialist. Assessment should be generally based on MAP2 but should include:

- preparation of a descriptive table/catalogue;
- identification of material suitable for scientific dating;
- an assessment of the significance of the assemblage;
- an assessment of the potential for further analysis to contribute to the interpretation of the archaeology of this site;
- an assessment of the potential for further analysis to contribute to environmental studies;
- an assessment of the condition of the assemblage and recommendations for retention/discard and archiving.

11.1.4 Scientific dating should be undertaken at this stage if it is required to fulfil the aims of the project. The contractor may contact WYAAS for advice.

11.2 Archive Consolidation

11.2.1 The site archive will be checked, cross-referenced and internally consistent. A fully indexed archive shall be compiled consisting of all primary written documents, plans, sections, photographic negatives and a complete set of labelled photographic prints/slides.

11.2.2 The complete archive (including finds) will be prepared in accordance with the requirements of the recipient museum (see section 10 above).

11.2.3 The original archive is to accompany the deposition of any finds, providing the landowner agrees to the deposition of finds in a publicly accessible archive (see

paragraph 9.3 above). In the absence of this agreement the field archive (less finds) is to be deposited with the West Yorkshire Archaeology Advisory Service.

11.3 Report Format and Content

11.3.1 Details of the style and format of the assessment report are to be determined by the archaeological contractor. However, it should be fully illustrated and include:

- background information;
- a description of the methodology;
- a full description of the results;
- an interpretation of the results in a local/regional/national context as appropriate;
- a re-evaluation of the aims and objectives of the project;
- recommendations for further artefact and environmental analysis;
- recommendations for additional scientific dating;
- recommendations for publication if warranted;
- the intended long-term storage location of the archive;
- a full bibliography.

Appendices to the report should include:

- unedited copies of specialist reports;
- a quantified index to the site archive, including finds and samples;
- a copy of this specification.

11.3.2 Location plans should be produced at a scale which enables easy site identification and which depict the full extent of the site. A scale of 1:50,000 is not regarded as appropriate unless accompanied by more detailed plan(s). The location of the trenches (as excavated) should be overlaid on an up-to-date 1:1250 O.S. map base.

11.3.3 Site plans should be at an appropriate, measurable scale showing the trenches as excavated and all identified (and, if possible, predicted) archaeological features/deposits. Trench and feature plans must include O.D. spot heights for all principal strata and any features. Section drawings must include O.D heights and be cross-referenced to an appropriate plan.

11.3.4 Finds that are critical for dating and interpretation should be illustrated.

11.3.5 The assessment report should be produced with sufficient care and attention to detail to be of academic use to future researchers.

11.4 Summary for Publication

11.4.1 The attached summary sheet should be completed and submitted to the West Yorkshire Archaeology Advisory Service for inclusion on WYAAS's website.

12. Assessment Report Submission and Deposition with the SMR

12.1 The archaeological contractor will supply a copy of the assessment report **directly** to the West Yorkshire Archaeology Advisory Service within a period of **two months** following completion of fieldwork, unless specialist reports are awaited. In the latter case a revised date should be agreed with WYAAS. Completion of this part of the project and a recommendation from WYAAS for further work or the discharge of the archaeological condition is dependant upon receipt by WYAAS of a satisfactory report which has been prepared in accordance with this specification. Any comments made by WYAAS in response to the submission of an unsatisfactory

report will be taken account of in finalising the report, within a timescale which has been agreed with WYAAS.

12.2 The report will be supplied on the understanding that it will be added to the West Yorkshire Sites and Monuments Record and will become publicly accessible once deposited with the WYAAS, unless confidentiality is explicitly requested, in which case it will become publicly accessible six months after deposition. Copyright - Please note that by depositing this report, the contractor gives permission for the material presented within the document to be used by the WYAAS, in perpetuity, although The Contractor retains the right to be identified as the author of all project documentation and reports as specified in the *Copyright, Designs and Patents Act* 1988 (chapter IV, section 79). The permission will allow the WYAAS to reproduce material, including for non-commercial use by third parties, with the copyright owner suitably acknowledged

12.3 A copy of the assessment report shall also be supplied to English Heritage's Regional Science Adviser (Andy Hammon, English Heritage, 37 Tanner Row, York Y01 6WP).

13. Final Report

13.1 The results of these excavations may warrant further analysis and reporting and/or publication in an appropriate archaeological journal. The assessment report will contain detailed recommendations for both analysis and publication but the requirement will ultimately be at the decision of WYAAS. The archaeological contractor should make provision for the project manager/supervisor to attend a meeting with WYAAS (in Wakefield) to discuss and finalise the requirements for the final report. The necessity for a meeting will be at the decision of WYAAS and the meeting may take the form of a telephone call.

13.2 The final text and illustrations (to a publication standard) will be submitted directly to WYAAS within a timescale agreed by both parties. Any comments made by WYAAS in response to the submission of an unsatisfactory report will be taken account of in finalising the report, within a timescale which has been agreed with WYAAS.

13.3 The report will be supplied on the understanding that it will be added to the West Yorkshire Sites and Monuments Record and will become a public document after an appropriate period of time (generally not exceeding six months).

13.4 Completion of this project and a recommendation from WYAAS for the full discharge of the archaeological condition is dependant upon receipt by WYAAS of i) a satisfactory final report and, should publication be warranted, ii) a copy of a letter from an appropriate journal editor confirming acceptance of the article.

14. General Considerations

14.1 Authorised Alterations to Specification by Contractor

14.1.1 It should be noted that this specification is based upon records available in the West Yorkshire Sites and Monuments Record. It is recommended that archaeological contractors should carry out a site inspection prior to submitting a tender. If, upon visiting the site or at any time during the course of the recording exercise, it appears in the archaeologist's professional judgement that:

> i) a part or the whole of the site is not amenable to recording as detailed above, and/or
>
> ii) an alternative approach may be more appropriate or likely to produce more informative results,

then it is expected that the archaeologist will contact WYAAS as a matter of urgency. If contractors have not yet been appointed, any variations which WYAAS considers to be justifiable on archaeological grounds will be incorporated into a revised specification, which will then be re-issued to the developer for redistribution to the tendering contractors. If an appointment has already been made and site work is ongoing, WYAAS will resolve the matter in liaison with the developer and the Local Planning Authority.

14. 2 Unauthorised Alterations to Specification by Contractor

14.2.1 It is the archaeological contractor's responsibility to ensure that they have obtained WYAAS's consent in writing to any variation of the specification prior to the commencement of on-site work or (where applicable) prior to the finalisation of the tender. Unauthorised variations may result in WYAAS being unable to recommend determination of the planning application to the Local Planning Authority based on the archaeological information available and are therefore made solely at the risk of the contractor.

14.3 Technical Queries

14.3.1 Any technical queries arising from the specification detailed above, should be addressed to WYAAS without delay.

14.4 Publicity

14.4.1 If the project is to be publicised in any way (including media releases, publications etc.), then it is expected that WYAAS will be given the opportunity to consider whether its collaborative role should be acknowledged, and if so, the form of words used will be at WYAAS's discretion.

14.5 Valid Period of Specification

14.5.1 This specification is valid for a period of one year from date of issue. After that time it may need to be revised to take into account new discoveries, changes in policy or the introduction of new working practices or techniques.

Helen M. Gomersall November 2006

West Yorkshire Archaeology Advisory Service

West Yorkshire Archaeology Advisory Service

Registry of Deeds

Newstead Road

Wakefield

WF1 2DE

Telephone: 01924 3067988

Fax: 01924 306810

Email: hgomersall@wyjs.org.uk

APPENDIX 3: CERAMIC CATALOGUE

Tr.	Context	Type	No	Wt	ENV	Part	Form	Decoration	Date range	Notes
A	1018	Bone China	4	55	2	Rim & base	Mug	Over glaze transfer print; painted number on base; 52/16	LC19th - EC20th	Probably one vessel and probably EC20th
A	1021	Blue Banded ware	2	2	2	BS	Hollow ware	Blue lines and bands ext	C19th	
A	1021	Stoneware	2	389	2	Base	Bottle/flagon	Green stoneware	M - LC19th	
A	1021	Stoneware	2	129	2	Shoulder	Flagon	Brown iron-wash on shoulder	M - LC19th	Joins with handle from 1023
A	1021	Stoneware	1	24	1	BS	Bottle/flagon	Green stoneware	M - LC19th	
A	1023	Stoneware	1	43	1	Handle	Flagon	Grooved handle	M - LC19th	Joins with body sherd from 1021
A	1023	Stoneware	1	163	1	Base	Flagon	U/Dec	M - LC19th	
A	1023	TP Bone china	1	8	1	Rim & base	Saucer	Moulded fluting	M - LC19th	
A	1023	TP Bone china	1	30	1	Profile	Saucer	Purple floral frieze inside rim	M - LC19th	
A	1023	TP Bone china	1	29	1	Profile	Saucer	Green leaf and wheatear printed design	M - LC19th	
A	1046	Bone China	1	6	1	Rim & base	U/ID	U/Dec	LC19th - EC20th	Odd sherd
A	1046	Mottled ware	2	12	1	Rim & base	Dish	Mottled glaze int & ext	C18th	
A	1046	Stoneware	4	99	1	Rim & base	Jar	Pale grey stoneware	C19th	
A	1046	TP Whiteware	1	1	1	BS	U/ID	Chinese landscape int	M - LC19th	
A	1046	TP Whiteware	1	8	1	Rim & base	Hollow ware	Blurred design; unidentified	M - LC19th	
A	1046	TP Whiteware	2	25	1	Base	Hollow ware	Green leaf and foliage design ext	M - LC19th	
A	1046	TP Whiteware	3	11	1	BS	Hollow ware	Green printed curvilinear design	M - LC19th	
A	1046	Whiteware	1	10	1	BS	Hollow ware	Gold line ext	M - LC19th	
A	1050	Bone china	1	4	1	Rim & base	Flatware	U/Dec	C19th	
A	1070	Blue Banded ware	3	22	1	Rim & base	Bowl	Blue bands and lines ext	C19th	Joins with sherds from context 1073
A	1070	Bone China	1	7	1	Rim & base	Saucer	Three gold lines int	M - LC19th	

Tr.	Context	Type	No	Wt	ENV	Part	Form	Decoration	Date range	Notes
A	1070	Whiteware	1	6	1	Base	Saucer	Two gold lines int	M - LC19th	
A	1073	Blue Banded ware	2	37	1	Rim & base	Bowl	Blue lines and bands ext	C19th	Joins with sherds from context 1070
A	1073	Cane Coloured ware	1	5	1	BS	?Bowl	White slip int	M - LC19th	
A	1073	Sponge printed ware	1	5	1	Base	Flatware	Leaf form printed design int	c.1840+	
A	1107	Whiteware	1	3	1	BS	Hollow ware	Angular profile	M - LC19th	
A	1120	Mottled ware	1	3	1	BS	Hollow ware	Mottled glaze int & ext	C18th	Burnt and blistered
B	2033	Stoneware	1	32	1	Base	Hollow ware	U/Dec	M - LC19th	
B	2033	Whiteware	1	22	1	Rim	Hollow ware	U/Dec	M - LC19th	
B	2034	Whiteware	8	74	7	Rim & BS	Plate	U/Dec	M - LC19th	Very heavily crazed and discoloured
B	2632	Colour Glazed ware	2	58	1	Lid	Teapot	Brown glaze int & ext	M - LC19th	
B	2632	TP Whiteware	1	3	1	BS	Hollow ware	Unidentified TP design ext	M - LC19th	
D	4039	Stoneware	1	13	1	BS	Bottle	Pale brown	M - LC19th	
D	4128	Creamware	1	3	1	BS	Hollow ware	U/Dec	c.1740 - c.1820	Flaked and discoloured
D	4144	TP Whiteware	1	16	1	Footring base	Hollow ware	Willow	M - LC19th	
D	4159	TP Whiteware	2	5	1	BS	Hollow ware	Commemorative coronation vessel	1937	Coronation of King George VI, May 12th 1937
D	4165	Bone china	1	5	1	Rim	Saucer	Blue sprigged decoration	C19th	
D	4169	BSGSW	1	590	1	Base	U/ID	U/Dec	Undated	Thick black deposit int
D	4169	Late Blackware	1	41	1	Handle & BS	Hollow ware	Black glaze int & ext	C18th	
Tr.	Context	Type	No	Wt	ENV	Part	Form	Decoration	Date range	Notes
D	4227	BSGSW	1	10	1	BS	Hollow ware	Rouletted and stamped design ext	C19th	

Tr.	Context	Type	No	Wt	ENV	Part	Form	Decoration	Date range	Notes
D	4233	Stoneware	1	32	1	BS	Hollow ware	Pale brown	M - LC19th	
D	4236	Stoneware	1	66	1	Base	Bottle	U/Dec	C19th	
D	4236	TP Whiteware	1	7	1	Footring base	Plate	Unidentified TP design int	M - LC19th	
D	4381	Bone China	2	2	2	Rim & BS	Flatware	U/Dec	C19th	
D	4381	Sponged ware	1	2	1	Rim	Flatware	Blue sponging	c.1830+	
D	4381	TP Pearlware	2	25	2	Footring base	Plate	Two Temples	c.1780 - c.1840	Pale blue print
D	4381	TP Pearlware	1	7	1	Rim	Flatware	Chinese landscape int	c.1780 - c.1840	
D	4381	Whiteware	1	3	1	BS	Hollow ware	U/Dec	M - LC19th	
D	4411	BSGSW	1	118	1	Base	Hollow ware	U/Dec	C19th	
D	4415	Slip Banded ware	1	15	1	BS	Hollow ware	Blue and grey-green bands ext	C19th	
WB	6096	Sponge printed ware	1	7	1	BS	Hollow ware	Green sponged printed motifs and brown band	c.1840+	
WB	6096	TP Whiteware	1	12	1	Rim	Hollow ware	Overglaze transfer printed design (stagecoach) ext	LC19th - C20th	
WB	6096	TP Whiteware	2	77	2	Rim & base	Hollow ware	Overglaze printed floral design ext	LC19th - EC20th	
		Total	81	2381	66					

Table 8 *Summary of the Ceramics.*

Trench	Context	Type	Number	Weight	ENV	Part	Form	Decoration	Date range
B	2584	Industrial component	1	11	1	Fragment	Trough	N/A	Undated
B	2618	CBM/Crucible	1	431	1	Rim/edge	Crucible	N/A	Undated
D	4165	Sewer pipe	1	1	1	Chip	Pipe	N/A	1850+
D	4169	Sewer pipe	1	21	1	Fragment	Pipe	N/A	c.1850+
D	4233	Clay tobacco pipe	1	2	1	Stem	Pipe	N/A	Undated

Table 9. *Summary of the Ceramic Building Material.*