NEXUS HERITAGE
A Member of the SRI Family

Stirchley Furnaces
Telford Town Park

Archaeological Investigations

Report No: 3072.R01

15/06/2011

Nexus Heritage
Commercial-in-Confidence

Nexus Heritage Controlled Document – Commercial-in-Confidence

Report Number	3072.R01	
Report Status	Draft	
Prepared by:	Paul Belford	Date: 8th June 2011
Checked by:	Kate Page-Smith	Date: 8th June 2011
Approved by:	Anthony Martin	Date: 15th June 2011
Revision Record		
Revision No.	Revision Summary	
A		
B		
C		

Nexus Heritage
Coppice House
Halesfield 7
Telford
Shropshire
TF7 4NA

and

Nexus Heritage
2 Parkgate Lane
Thornton Hough
Wirral
CH64 7TP

and

Telford and Wrekin Council
Civic Offices
Coach Central
Telford
TF3 4WZ

Nexus Heritage
71 High Street
Fordingbridge
Hampshire
SP6 1AS

CONTENTS

FIGURES

The cover image is taken from a drawing made of the site by Kathleen Peel on 9th March 2011 during the community archaeology project, with the kind permission of the artist.

TABLES

DRAWINGS

These are provided in Appendix 2.

SUMMARY

Nexus Heritage was commissioned by Telford and Wrekin Council to undertake Historic Building Recording at the Stirchley furnaces site in Telford Town Park (NGR SJ 700 075). Building recording of a site initially identified as 'the small furnaces' revealed the substantially well-preserved remains of two of the original blast furnaces built by the Botfield concern in the 1820s. These remained in use until the 1880s, and were then adapted as part of the Wrekin Chemical Works, which used the site into the twentieth century.

As a result of these initial findings, further excavation work – including a community archaeology project - was undertaken, which sought to further refine the dating, sequence and understanding of the site. Additional historical research was also undertaken in the Botfield papers at the John Rylands Library.

The surviving blast furnaces stand up to 6.5m above the original ground surface, although partly buried and partly collapsed. Surviving features include blowing and casting arches, furnace stacks, passageways, flues and associated structures. The furnaces are tentatively associated with Thomas Botfield's hot blast patent of 1828, which represents a significantly early attempt to introduce the hot blast method to the ironmaking process. The Stirchley furnaces were also unusual in being associated with a refinery; a process which normally took place at the forge. An increase in ground levels around the furnaces and elsewhere on site during the twentieth century has resulted in good preservation.

The furnaces stand within a wider complex. Visible surviving features include the remains of an engine/boiler house, ore storage bins; there is also the potential for below-ground survival of the refinery and hot blast stoves. Site levelling operations after the closure of the ironworks appear to have sealed stratigraphically-intact deposits of metallurgical debris.

The site is of high local and regional significance, and of considerable archaeometallurgical interest. It represents a rare archaeological survival of a complete hot blast complex of the early nineteenth century. If the tentative association with the Botfield patent can be confirmed, then the site will be of national significance. The site is worthy of publication in a national journal.

Further research and investigation is recommended as work on the site proceeds; consideration should also be given to the preparation of a Conservation Management Plan. Community engagement with the archaeological process should be sustained and developed in the future.

1. INTRODUCTION

This report describes a series of archaeological investigations and historical research at the Stirchley furnaces site in Telford Town Park. The site is located at Ordnance Survey NGR SJ 700 075 (Fig. 1). Fieldwork was undertaken by Nexus Heritage between February and April 2011, with historical research and reporting between April and June 2011.

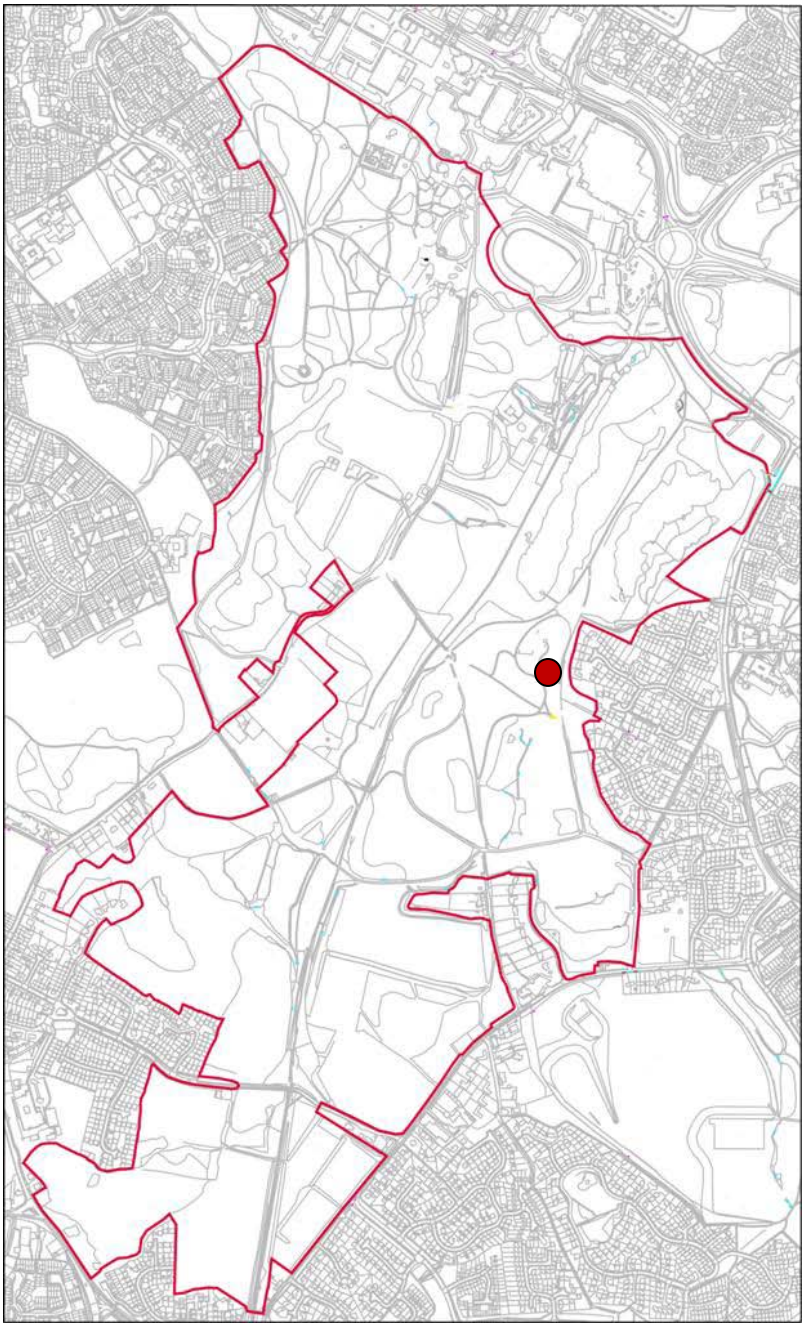

Fig. 1. Site Location. The Town Park boundary is shown in red. Crown Copyright © All rights reserved. Licence Number WL 10737.

1.1 Project background

Telford and Wrekin Council has been granted planning permission to undertake work in Telford Town Park as part of Stage 2 of the Parks for People project funded by the BIG lottery fund and the Heritage Lottery Fund. The Town Park contains a number of features of historical and archaeological interest. An archaeological planning condition was placed against the Parks for People Stage 2 Master Plan proposals for groundworks at Randlay Pool Picnic Area and Stirchley Chimney/Furnace areas. The condition, placed by Shropshire Council Conservation and Archaeology section, states:

> *No development shall take place until a scheme to allow access to any archaeologist nominated by the Local Planning Authority to observe the excavations and record items of interest, has been submitted to and approved in writing by the Local Planning Authority. Reason: The area is of archaeological potential and it is important that any archaeology features and finds are properly recorded.*

During the course of preparatory works, it became clear that a structure within the Stirchley Chimney/Furnace area would be impacted by the proposed scheme. Consequently Nexus Heritage was commissioned by Telford and Wrekin Council in December 2010 to undertake a Level 3 Historic Building Record (as defined by English Heritage). This work was undertaken in February 2011, and led to the development of a community archaeology project involving local volunteers in excavating and recording the furnace and some of the surrounding features during March and April 2011.

1.2 Site location, geology and topography

Telford Town Park, formerly located in the parishes of Dawley, Stirchley and Malinslee, is situated in the borough of Telford and Wrekin, the largest town in the county of Shropshire (National Grid Reference: SJ 700 077). It is located approximately 13 miles (21km) east of Shrewsbury and 30 miles (48km) west of Birmingham and is connected to them both by the M54/A5. The Town Park consists of 170 hectares of public open space and was a key development in the construction of Telford, which was first designated in 1963 as Dawley New Town.

The Town Park is bounded by the large residential areas of Dawley to the south west, Malinslee to the west, Stirchley and Randley to the east and Southall to the south. To the north are the A442 and the M54, local government offices, a commercial district and a leisure park, including an ice-rink, bowling and bingo centre. The Silkin Way, formerly the Shropshire Canal and the Wellington and Coalport railway and now a cycle route, runs north to south through the centre of the park. The River Severn is approximately 4.5 km to the south and the Mad Brook, which originally flowed from north to south along the eastern boundary of the site, now emerges to the south east of the Town Park. There are 13 pools in the Park, including Randley Pool, Withy Pool, Blue Pool and Hinkshay Pool, some of which are remnants of the previous industrial activity in the area. In addition to informal woodland areas and agricultural land, the Town Park contains a number of formal gardens and a children's theme park called 'Wonderland'.

The majority of the Town Park is located within the former ancient parish of Dawley. Here, the land falls gently to the south-east and its north east boundary was defined by the Randlay valley, which runs through the centre of the site approximately outlined by the Silkin Way. In this area the seams of the Upper Coal Measures lay deeper than elsewhere in the parish, under siltstones and sandstone and are covered mostly by boulder clay. The ancient parish of Stirchley was situated to the east of this valley; roughly triangular in shape, it consisted of gently undulating terrain. Stirchley was on the edge of the East Shropshire Coalfield and was underlain by the Coalport Beds of the Upper Coal Measures. The extensive boulder clay, which was subsequently quarried for brick making, also produced heavy soil suitable for pastoral farming.

The Town Park is not located within a Conservation Area or an Area of Archaeological Importance and does not contain any Listed Buildings, Registered Parks of Gardens or Battlefields or Scheduled Ancient Monuments.

1.3 Summary of ironworking process and terminology

This summary provides an explanation of some of the technical terms relating to processes described in this report as they existed during the first half of the 19th century. It may be helpful to refer to this when reading sections 4, 5 and 6.

Iron was produced by **smelting** iron ore in a **blast furnace**. The 'blast' was made by blowing cylinder(s) powered by a steam engine; usually at this time the blast was 'cold' (ie. unheated) but by the 1830s methods of pre-heating the blast to create 'hot blast' were recognised as being more efficient. The furnace consisted of a masonry or metal **stack**, lined with firebrick. The blast was introduced to the furnace at the base of this stack, through one or more nozzles called **tuyeres** located in one or more 'blowing arches'. The ingredients: iron ore, fuel (coke, derived from coal) and a flux (limestone, to help the slag run off), were loaded into the top of the furnace. The smelting process involved temperatures of up to 1300°C inside the furnace, and both the molten iron and the slag were 'tapped' from the base of the furnace at the 'casting arch'.

The furnace was operated continuously for a period of time known as a **campaign**. Traditionally (in older furnaces) a nine-month period, by the early 19th century furnaces were being run for up to two or three years. At the beginning of the campaign the furnace was 'blown in'; when it became too worn to continue operation it was 'blown out'. Once cool the 'bear' was removed from the base of the furnace (an agglomeration of iron and furnace lining which built up during the campaign', and the furnace was relined and other building works undertaken to repair the structure and improve its operation.

The iron was cast into moulds to make ingots (known as **pigs**). This **cast iron** was then taken to the **refinery** where it was re-heated to purify it, and then sent to the forge where the bars were **puddled** (heated again to form a bloom); this bloom was then shingled (hammered) and/or rolled (extruded in a 'rolling mill'). The iron that emerged from the forge was called **wrought iron**.

2. AIMS AND OBJECTIVES

The purpose of the archaeological investigation at Stirchley Furnaces was initially to provide a Level 3 historic building record in advance of the demolition of the structure. As noted in English Heritage *Understanding Historic Buildings: a guide to good recording practice*, a 'Level 3 record may also be appropriate when the fabric of a building is under threat but time or resources are insufficient for detailed…research' (p.14). As the recording progressed, it became apparent that the structure survived in a much better state of preservation than had hitherto been recognized; consequently the aims of the project were adjusted to enable only partial dismantling for stability and Health and Safety reasons. The building recording exercise was supplemented by excavation to reveal the further extent of the furnaces, and by a landscape survey of the site to place the furnace structure in context. The specific objectives of the project were:

- to provide a record of the furnace structures to inform proposals for repair, conservation and alterations;
- to provide general information about the development and alterations made to the furnaces and their environs over time;
- to provide material which could support future interpretation on site
- to develop community and public participation in historic environment work in the Town Park

In addition to fieldwork, a visit was made to the John Rylands Library at the University of Manchester to examine the Botfield family papers. The aim of this was to build up a more detailed picture of the operation of the site as a whole – including a search for detailed information on the arrangement, construction and operation of the furnaces.

3. METHODOLOGIES

The different methodologies deployed in undertaking the archaeological investigation are described separately in this section; however understanding of the site (as described in sections 4 and 5 below) has been arrived at through a combination of these methods.

Historic building recording was undertaken by Paul Belford and Kate Page-Smith in February and March 2011, with monitoring of rubble removal, excavation and dismantling by Paul Belford in March and April 2011. Further building recording, as well as the landscape survey, was undertaken as a community archaeology project with volunteers led by Paul Belford and Kate Page-Smith in April 2011. Historical research and reporting was completed by Paul Belford during April, May and June 2011.

Particular thanks are due to the volunteers who participated in the excavation during 7th, 8th and 9th April. These were: Craig Baker, Nigel Cane-Honeysett, Janis Cane-Honeysett, Jim Cox, Jo Haseman, Ron Haseman, Kathleen Peel and Malcolm Peel. Thanks also to David Cranstone (Cranstone Consultants) for many useful discussions on early 19th century blast furnace practice in general, and the origins of hot blast in particular.

3.1 Historic building recording

The recording of the furnace structure was undertaken in accordance with the Institute for Archaeologists' *Standard and Guidance for the archaeological investigation and recording of standing buildings or structures* (2008), which notes that the purpose of such work helps to seek better understanding of the building and to inform the formulation of a strategy for its conservation and future management.

The recording work was undertaken to RCHME/EH Level 3 survey, as being most appropriate for this building. As noted in English Heritage *Understanding Historic Buildings: a guide to good recording practice*, a Level 3 survey comprises an analytical record which includes:

'an account of the evidence on which the analysis has been based, allowing the validity of the record to be re-examined in detail. It will also include all drawn and photographic records that may be required to illustrate the building's appearance and structure and to support an historical analysis. The information contained in the record will for the most part have been obtained through an examination of the building itself'.

The recording fieldwork was undertaken on 7th, 9th and 10th February 2011 and comprised the following elements:

Written record. The written record consisted of hand-written field notes. The main purpose of the written record was a description of the form, function (both present and historic) and development of the building in support of the photographic and drawn records.

Drawn record. The drawn record consists of a series of hand-drawn elevations and plans made in the field using pencil on waterproof drawing film, and subsequently scanned and redrawn using Adobe Illustrator software. They include:

- An overall plan at 1:50 of the furnace structure;
- Elevations at 1:20 of east and west sides of the furnaces, showing coursing and other details;

These drawings have been reduced for inclusion in this report, but full-sized copies are provided on a CD accompanying this report.

Photographic record. This was made using a 10MP digital SLR camera, and included general views of the furnace structure in its setting, views of the main elevations, detail views of features on the elevations, and internal views (where possible) of arches, stack interiors and other details. Selected photographs are included in this report; however the full photographic archive will also be provided on a separate CD.

3.2 Excavation

Excavation was undertaken in two stages. The first stage took place between 22nd and 25th March 2011, and comprised machine reduction of ground levels immediately surrounding the furnace, under strict archaeological supervision. Excavation was immediately followed by rapid recording of the elevations and features exposed using hand-drawing and photography, and then the excavated areas were backfilled for safety.

At the southern end of the furnace, this process revealed that considerable historic truncation and modification of the structure had taken place. It was agreed that the best solution to enable a sufficiently rigorous archaeological investigation to take place here was to undertake hand-excavation with the assistance of skilled and experienced volunteers as part of a training programme. This took place on 7th, 8th and 9th April 2011.

Fig. 2. Left: machine reduction of ground levels around the furnace structure under archaeological supervision; right: community archaeology programme of hand excavation at the southern end of the structure.

All excavation work was undertaken in accordance with the Institute for Archaeologists' *Standard and Guidance for archaeological excavation* (2008), which notes that the purpose of excavation is to:

'examine the archaeological resource within a given area or site within a framework of defined research objectives, to seek a better understanding of and compile a lasting record of that resource, to analyse and interpret the results, and disseminate them'.

The archaeological record of the excavation consists of the following elements:

Written record. This was made using a combination of field notes and pro-forma recording sheets. Context numbers were allocated to individual features, deposits and structures in accordance with conventional archaeological practice.

Drawn record. The drawn record consists of a series of hand-drawn plans made in the field using pencil on waterproof drawing film, and subsequently scanned and redrawn using Adobe Illustrator software. These include:

- Overall plan at 1:50 of the excavated area in relation to the remainder of the site
- Profiles at 1:20 of the interior of the north and south furnace stacks;
- Detailed plan at 1:20 of the excavated parts of the southern furnace.

These drawings have been reduced for inclusion in this report, but full-sized copies are provided on a CD accompanying this report.

Photographic record. This was made using a 10MP digital SLR camera, and included general views of the excavated area, detail shots of individual features, 'working shots', elevations and other views. Selected photographs are included in this report; however the full photographic archive will also be provided on a separate CD.

3.3 Landscape survey

Landscape survey was undertaken in accordance with the general principles and techniques described in English Heritage *With Alidade and Tape* (2002), which notes how 'traditional graphical … techniques are of value in recording and understanding' and that a systematic record can enable interpretation of:

'form, including shape, size and orientation; relative (and sometimes absolute) chronology, often by demonstrating relationships between features; location and topographical setting; function or purpose. Surveys also provide a statement on the condition of earthworks and other historic features, aid their management and conservation, and inform archaeological decisions on them (regarding, for example, scheduling, preservation or excavation).'

The landscape survey was undertaken with the help of volunteers during the community archaeology stage of the project. Measurements were taken using hand-tapes, with baselines being established and tied in to key site features by triangulation, and offsets taken where possible. Due to the dense vegetation and difficult conditions underfoot it was not always possible to take precise measurements of all points (Fig. 3, overleaf)

A measured sketch was produced on site using pencil on waterproof drawing film. This was subsequently scanned and redrawn using Adobe Illustrator software. The drawing was produced at 1:100, and has been reduced for inclusion in this report (Drawing 1, Appendix 2), but a full-sized copy is provided on a CD accompanying this report.

Fig. 3. Landscape survey being undertaken using hand tapes.

Some photographs of features were also taken using a 10MP digital SLR camera, and included general views of the excavated area, detail shots of individual features, 'working shots', elevations and other views. Selected photographs are included in this report; however the full photographic archive will also be provided on a separate CD.

3.4 Historical research

Historical research consisted of examination of secondary source material on local history and ironworking generally, and the Botfield concern in particular. A visit was made to the library of the Ironbridge Gorge Museum Trust to examine 20th century photographic material.

A visit was also made to the John Rylands Library at the University of Manchester, for an examination of the Botfield archive. Although in places comprehensive, the archive's preservation and coverage was limited with regard to the Stirchley furnaces; nevertheless there remains considerable potential for future research, as outlined in section 7 below.

4. HISTORICAL BACKGROUND

The Stirchley furnaces were in use from 1822 until the 1880s for smelting iron, and the site was subsequently used by the Wrekin Chemical Company to extract by-products from charcoal. This section of the report provides detailed information about the Stirchley site during the blast furnace period, together with background on the Botfield family who built the site, and associated technological developments. It also examines the evidence for the later development of the site.

4.1 Stirchley before the 1820s

Before 1301 Stirchley, Dawley and Malinslee were all situated within the Royal Forest of Mount Gilbert, the former name of the Wrekin. The term 'ley' (an Anglo-Saxon term for a clearing in the forest) implies that these settlements were deforested and cleared during this period. Place name evidence also suggests that Stirchley was derived from 'stirk', meaning young horned beasts such as cattle (Page-Smith 2010, 13-14).

Before 1086, the manor of Great Dawley, occasionally referred to as Dawley Pantulf, was held by Grim and was considered a part of Wellington manor. It was then held in chief by Roger of Montgomery, Earl of Shrewsbury and William Pantulf held it under him. It is likely that Stirchley or 'Styrcleage' was prior to c.1003 held by Wulfric Spot, who upon his death left it to Burton Abbey. However, the settlement was not mentioned later in the Domesday Book. From 1185 to c. 1285 it was recorded that both Stirchley and Stirchley Grange were overseen by the Brimpton family, Lords of Longford.

A large amount of woodland clearance took place in Stirchley after 1277 when Buildwas Abbey was licensed to assart 60 acres in Stirchley. This was probably when Stirchley Grange was established (SHER No: 02923, SJ 7022 0703). By 1375 Richard, Earl of Arundel and Surrey had become the overlord of Stirchley, followed by his son (also Richard) in 1382. At the end of the 15th century the majority of the land in Stirchley was in divided between three large holdings that became separate freehold estates after the dissolution. These included Grange Farm and Holmer Farm, which were both directly associated with Buildwas Abbey, and Stirchley Hall Farm that was held by the Earl of Arundel from Buildwas Abbey. The Stirchley Grange estate had been let on long lease by Buildwas Abbey before 1500. After the dissolution in 1536, the Stirchley Grange and Strichley Hall estates were acquired by Edward, Lord Grey of Powis. In the 16th and early 17th centuries the Grange and Stirchley Hall were described as manors. From this period until the 19th century Stirchley parish contained only four principal farmsteads and a cluster of cottages and smallholdings around the church (Baugh 1985, 184-185).

The first reference to mining in the area was in 1526-9 at 'Wodds Copy' in Great Dawley. It was again mentioned, with coal mining, in a will in 1569, at which time it was held by John Boycott who had a 21-year lease of 1555-6. At this point Ironstone was more highly sort after than coal. The first evidence of iron working was a forge operated by Richard of Dawley recorded in c. 1180.

4.2 The Botfield family

The Botfield family appear to have originated in Dawley, and their involvement in industrial activities began in 1753, Beriah Botfield, a “collier of Great Dawley”, became one of four partners who leased mining land Lightmoor. Beriah's son, Thomas (1738-1801) was originally an agent to the estate of Isaac Hawkins Browne (Trinder 2000, 82-84). He became one of the partners of Lightmoor ironworks in June 1758, and his vigorous management of that concern enabled access to capital and support from other Shropshire businesses. He began to develop Isaac Hawkins Browne's Old Park estate from 1788, with the first furnace operational by 1790 and further investments including pumping and winding engines; by 1801 four blast furnaces had been erected at Old Park. These were powered by a Boulton and Watt blowing engine, acquired that year for £828; there was also a new forge rolling mill powered by a 56 h.p. Boulton and Watt engine which cost £1,675 (Trinder 2000, 51-53).

Many of these improvements were carried out under the management of the entrepreneurial inventor Gilbert Gilpin. Gilpin had worked for John Wilkinson at Bersham, and later Boulton and Watt in Birmingham; after three years in South Wales he returned to Shropshire in 1799 as Thomas Botfield’s agent. Gilpin devised a method of making wrought-iron chains to improve safety in the mines, an invention evidently seized upon by the Botfields; however by 1814 Gilpin had left the firm to set up on his own as a chain maker (Clarke n.d.).

Fig. 4. Signatures of Thomas Botfield the elder (left), on a lease of 1773; and of Thomas Botfield the younger and his brother William on an agreement of 1829 (right). From documents in the John Rylands Library at the University of Manchester.

After the elder Thomas Botfield’s death in 1801 his estate passed to his three sons, Thomas, William and Beriah. William managed the Old Park works, but the three brothers met there each quarter to divide the profits. In 1806-1807 the output of pig iron there rose to 9200 tons, half of which was converted to wrought iron in the works forges. By this time the Old Park works was the largest ironworks in Shropshire and the second largest in Great Britain (Trinder 2000, 82). In 1815 the Old Park works consisted of four blast furnaces, a forge and associated collieries. Thereafter the business expanded considerably, as two pairs of blast furnaces were brought into operation at Stirchley (the site is also confused with Hinkshay, for which see below) during the 1820s.

By 1830 the Botfield enterprise was producing 15,300 tons of pig iron a year, only slightly less than the Lilleshall company who were then the largest producers in Shropshire (Trinder 2000, 83-84).

Of the sons, William Botfield appears to have maintained the greatest involvement in running the business day-to-day. However Thomas also made a contribution, and took out two patents: the first, in 1809 for iron roofs in buildings, and the second, in 1828 for iron smelting using hot blast (see below).

Generally, the ironworks were managed by agents, including Gilpin and later others, enabling the Botfields to enjoy their extensive country estates. Thomas Botfield died in 1843, and his brother William in 1850, and control of the family business passed to their nephew Beriah, whose father, also Beriah, had died in 1813. Beriah Botfield (1807-1863) was MP for Ludlow in the 1840s and 1850s. The gradual decline of the Botfield family's business was symptomatic of the Shropshire iron trade's failure to adapt to modern methods (Trinder 2000, 85-86). In 1856 the business was divided up, and in 1877 the Old Park ironworks ceased operations (Access to Archives 2011).

4.3 The Stirchley ironworks and furnaces

The Botfield accounts describe in considerable detail the financial expenditure at the Stirchley furnaces during the first four decades of its operation. Much of the information below is derived from the Cash Account Books in the John Rylands Library, and from a written valuation of the site made in 1856. It is clear that these primary sources have the potential to shed a great deal of light on the construction and operation of the site; however due to the time constraints of the present project it has not been possible to go through the whole life of the furnaces in detail. Consequently this report presents a summary. (For an explanation of some of the basic processes involved, and the terminology, please refer to section 1.3 above.)

On 31st August 1813 Thomas and William Botfield leased 1,223 acres of land in Malinslee and Stirchley from Isaac Hawkins Browne of Badger for 21 years (SA: 513/2/3/1/55). This included both the Old Park and Stirchley sites, the former having already been leased by the Botfields since 1803. The three Botfield brothers – Thomas, William and Beriah – had taken control of the Old Park ironworks on the death of their father in 1801, and by 1815 had developed the business to include such prominent customers such as Boulton and Watt of Birmingham, John Bradley of Stourbridge and John Hazeldine of Bridgnorth (Trinder 2000, 123).

In the spring of 1822, the three Botfield brothers turned their attention from Old Park to Stirchley, each making an initial investment of £2000 into the construction of the furnaces (JRL: BOT 2/31/2). The first work took place on the site on 26th May 1822, when Samuel Dodd was paid for “wheeling off soil for new erections”. Further preparations took place over the summer and into the autumn, including pile driving, drainage works and the building of foundations; and payment to John Tart for “making Stays for Engine House”. The following year saw substantial deliveries of bricks, clay, sand and other materials, including firebricks and castings. Most of these were supplied by other sites in the Botfield empire: Old Park producing much of the ironwork and firebricks, with more bricks from Stirchley colliery.

In July William Hayward was paid for “getting out ground for the Water Regulator” and for “getting Scaffold poles to Works”. After further deliveries of building materials, a boiler was delivered from Old Park on 19th October, and William Hayward was engaged in the completion of the Blast Engine house.

Three furnaces had been completed by November 1823, and there are several payments in the accounts for "getting Coals to dry the Furnaces". Joseph Burkes and Robert Jones were employed to "make fires at the Furnaces" day and night throughout November and December, and into January. This would have been necessary to drive out all of the moisture from the structure before the furnaces could start to smelt iron. However, although the furnace stacks were complete, they were not connected to the rest of the site. The winter of 1823-4 saw work on the incline, the construction of a "bridge" or gantry to connect the furnaces with the loading area and the delivery of more specialised equipment – including 6 Tuyere pipes on 14th December and pig moulds, wheelbarrows and shovels in January 1824.

Furnaces 1, 2 and 3 were blown in on 8th February 1824 (JRL: BOT 2/31/2). The Old Park furnaces supplied beer, and John Austin, William Taylor and Samuel Keay were paid for rolls, mutton and potatoes as a "Treat to the Workmen when the Furnaces blowed in". However the site was still being finished around them. New equipment delivered during the spring included anvils, coke baskets and consumables such as limestone and coke; rails were laid and more work was done to the incline. There was also general building work around the casting areas, and the installation of a "New Blast Engine" over the summer. This was supplied complete by Old Park for the sum of £2,206, 13 shillings and sixpence. Its installation required considerable expense in the creation of a reservoir, drains and the laying of numerous blast pipes around the site; this work occupied Samuel Dodd, Thomas Jones, Thomas Yale and others well into the autumn. This second blast engine was probably for use in the Refinery, which was under construction at the time (JRL: BOT 2/31/2).

From mid-1824 and through 1825 the operation of the site settled down into a steady rhythm of iron smelting in the three furnaces. In the first year the output from the furnaces was erratic, as shown in Table 1, below:

	May	*June*	*July*	*August*	*Sept*	*October*	*Nov*	*Dec*	*Total*
tons	325	250	171	270	200	160	315	150	1841

Table 1. Iron production during the first eight months of the Stirchley furnace complex (three furnaces).

Once the site had settled down during the first half of 1825, production from the three furnaces seems to have been fairly steady at between 400-500 tons per month for the remainder of the year. However this was something of a high point in production, as the accounts record further significant building works in the following years.

The three furnaces continued in blast throughout 1825, but by June 1826 No.1 furnace had been blown out. On 24th June six men were paid for "getting Bear out of No.1 Furnace". Further extensive building work in the autumn included new blast pipes – payments being made for the pipes themselves as well as excavations to accommodate them and adjusting and setting up (JRL: BOT 2/31/2). However it is not clear whether these relate to the repair of No.1 Furnace, or the construction of the new No.4 Furnace.

No.4 Furnace was pre-heated during November and December 1826, and in January 1827 all four furnaces were in blast. This situation was short-lived, for the newly-recommissioned No.1 Furnace was again out of operation by May 1827, and did not come on stream again until February 1828. The total iron production for that month (apparently with all four furnaces) was only 290 tons. The same period saw additional improvements to the blast system for all furnaces, including the replacement of boilers and further adjustments to the pipes. No.2 Furnace was blown out at some stage in April or May 1828, and production in July was only 120 tons (JRL: BOT 2/31/2).

Modifications were also being undertaken later in the year to No.1 furnace. These included a payment of over £16 to Thomas Jones for extensive work in November and December 1828, including repairs to the casting arch, 'air furnace', a chimney at the furnace and other work (JRL: BOT 2/31/2). In January 1829 No.2 Furnace was being heated, and was back in operation in April; No.1 furnace followed a couple of months later – but by the autumn No.3 Furnace had been blown out.

The earliest depiction of the site[1] is on the Ordnance Survey map of 1833 (Fig. 5), which shows the 'Furnaces' and nearby forge (marked as 'Iron works').

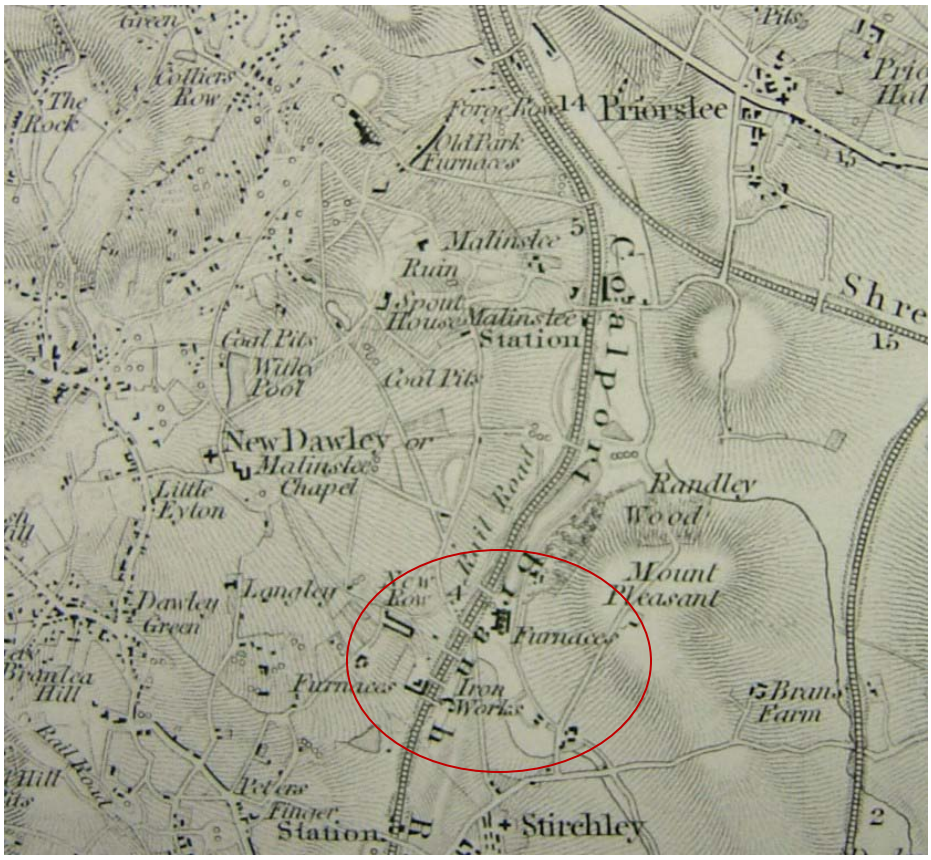

Fig. 5. Ordnance Survey Map, 1833.

[1] Barrie Trinder (1977, 86-87) provides John Thornton's account of his visit to Botfield's works at Stirchley in 1819. In fact the description is probably Old Park as Stirchley was not yet built. Trinder illustrates the account with a picture entitled "near Shiffnal" [sic] (wrongly captioned by Trinder) and suggests that this probably of Stirchley, but the picture was published in 1820 and so again pre-dates the construction of the Stirchley ironworks (IGMT 1973.281; Joanne Smith, *pers. comm.*).

The general pattern of operations on the site in the 1820s and 1830s appears to have settled down to a pattern. Rarely were all four furnaces in blast at once; usually there were three, but sometimes the site was down to two furnaces (Riden and Owen 1995, 46). For most of the summer of 1833, indeed, only No.3 Furnace was working. Inevitably the stresses and strains on the furnace structure imposed by continuous operation at over 1300°C meant that frequent repairs were necessary. However the Stirchley site appears to have been unusually trouble-prone in its first few years, with fairly comprehensive rebuilding of both furnace stacks and blast apparatus at regular intervals. Payments for repairs to the Blast Engines and associated machinery were made monthly. In 1830 the Stirchley site produced just under one-fifth of the output of the entire Botfield concern.

During this early period ironstone was sourced from Hinkshay and Stirchley collieries, and coal and lime from Stirchley. The iron produced was sent down the canal to Coalport, and by road via Hollingswood. As well as payments to carriers, the accounts also record charges levied by the "Proprietors of the Shropshire Canal" and by Joseph Reynolds for wharfage of the iron at Coalport (JRL: BOT 2/31/2; BOT 2/31/3). For most of the 1840s the site produced between 4,000 and 5,000 tons of pig iron per year.

The site is shown on the Stirchley Tithe Map of 1838 (Fig. 6), which does not provide a great deal of detail. The ironworks, its reservoirs and the Randlay pit and brickworks are grouped together as a single plot of land, described as "Ironworks, Cinderhill, Coke Hearths, Brickworks, Engine Pit, Mount, Pond &c." (SA: D/3651/D/17/21). This shows an ill-defined cluster of buildings in the approximate location of the furnace complex.

Fig. 6. Stirchley Tithe Map, 1838.

There has been confusion in much of the literature on the Botfield enterprise between sites at Stirchley, Hinkshay and Dark Lane. Barrie Trinder ambiguously describes "two pairs of blast furnaces at Hinkshay and Stirchley" during the late 1820s and, later another "two furnaces at Dark Lane" (Trinder 2000, 123).

However detailed examination of the Cash Accounts suggests that there were no blast furnaces on a separate site at Hinkshay at this time; rather there were four blast furnaces at the Stirchley site with most of the forging operations taking place at the Hinkshay site (also known as Stirchley Forge). The two sites were less than half a mile apart. Journals and inventories describe "Dark Lane and Hinkshay Furnaces" as a single entity in the 1840s and 1850s (JRL: BOT 2/28/1-2) although monthly accounts do not refer to "Hinkshay Furnaces". Analysis of the physical remains and documentary sources, and comparison with other contemporary examples (see section 6, below) confirms this.

The most detailed account of the Stirchley Furnaces site appears in a *Valuation of the Ironworks and Collieries at the Old Park and Stirchley Estate* dated 1856 (JRL: BOT 4/4). This was unfortunately not accompanied by a map, however the detailed description provides a good indication of the scope and scale of the complex. In summary, as well as the Furnaces, the site included:

- Double Power Condensing Blast Engine, with 52-inch cylinder and 8' 6" stroke... with two round and two Lancashire boilers;
- Blowing Apparatus: a 90-inch cylinder with 8' 6" stroke together with all the necessary valves and other accoutrements;
- Four Hot Air Ovens (ie. hot blast stoves)
- Water pipes and blast pipes to and between the furnaces, hot air ovens and water reservoir; and further blast pipes to the Refinery
- Four Casting Houses
- Two Blacksmiths Shops
- Foundry
- Refinery
- Coal Wharfs with weighing machines
- Limestone Wharf with crane
- Furnace bridge with carriages for coal, ironstone and cinders
- Incline with winding engine and associated machinery
- Office and Store Room
- Carpenters' Shop
- Stables

No. 3 Furnace is described as 'out of blast' but the other three were presumably in operation up to the time of the Valuation.

Despite the lack of a map, the Valuation does provide some spatial information about the site.

There were 160 feet of water pipe running from the Reservoir to the "furnaces and refinery", and a further 249 feet from the Reservoir to the "Tuyere houses along the back of the furnaces". It would appear that by this time a single blast engine supplied blast both to the furnaces and to the refinery (where smaller batches of iron were remelted and cast). There were "84 feet of 9-inch pipes from the end of the Regulator to the Refinery", with a further 7' of seven-inch pipe leading to the three tuyeres in the Refinery.

The relationship of the hot air ovens to both the blast engine and the furnaces can also be surmised, as shown in Table 2, below:

	14-inch pipe from Blast Engine to Regulator	*14-inch pipe from Regulator to Hot Air Oven*	*9-inch pipe from Regulator to Hot Air Oven*	*9-inch pipe from Hot Air Oven to back tuyere*	*7-inch pipe from Hot Air Oven to back tuyere*
No. 1 Furnace	78' 0"	-	7' 6"	5' 6"	24' 0"
No. 2 Furnace	72' 0"	23' 0"	-	5' 6"	15' 0"
No. 3 Furnace	72' 0"	23' 0"	-	4' 9"	15' 0"
No. 4 Furnace	76' 0"	-	32' 0"	3' 6"	15' 0"

Table 2. Lengths of blast pipes as shown in the 1856 Valuation. No.4 Hot Air Oven appears to have been supplied directly from the blast main to the refinery, hence the additional length of 9-inch pipe.

The 1856 Valuation came about at the expiry of the Botfield lease, which Beriah Botfield either could not or would not renew. As a result the Botfield estate was broken up, and the Stirchley Furnaces leased (along with mining royalties) to the Old Park Iron Company (Baugh 1985, 190). In 1859 four furnaces were noted as being in blast – although only until the end of May (Riden and Owen 1995, 46). The furnaces do not appear to have been worked again before the Old Park concern was wound up in 1871; the Stirchley site was then leased to the Wellington Coal and Iron Company in 1874. Despite massive investment, including the construction of the landmark 200-foot chimney, the Wellington Coal and Iron Company failed in 1877. The furnaces then reverted to the landowner, Edward Cheney (Baugh 1985, 190-191).

The nearby forge and rolling mills, on the other hand, were Botfield's own property, and were sold in 1873 to the Haybridge Iron Company (SA 1265/261). The same company subsequently took on the Stirchley furnaces and revived smelting operations there in 1882-1883, although only two furnaces were ever in blast; by 1883 the furnaces were described as "dismantled" (Riden and Owen 1995, 46).

The site is shown at this time on the Ordnance Survey map of 1882 (Fig. 7, overleaf), where it is marked 'Old Park Ironworks'; the forge at Hinkshay is called 'Stirchley Iron Works'.

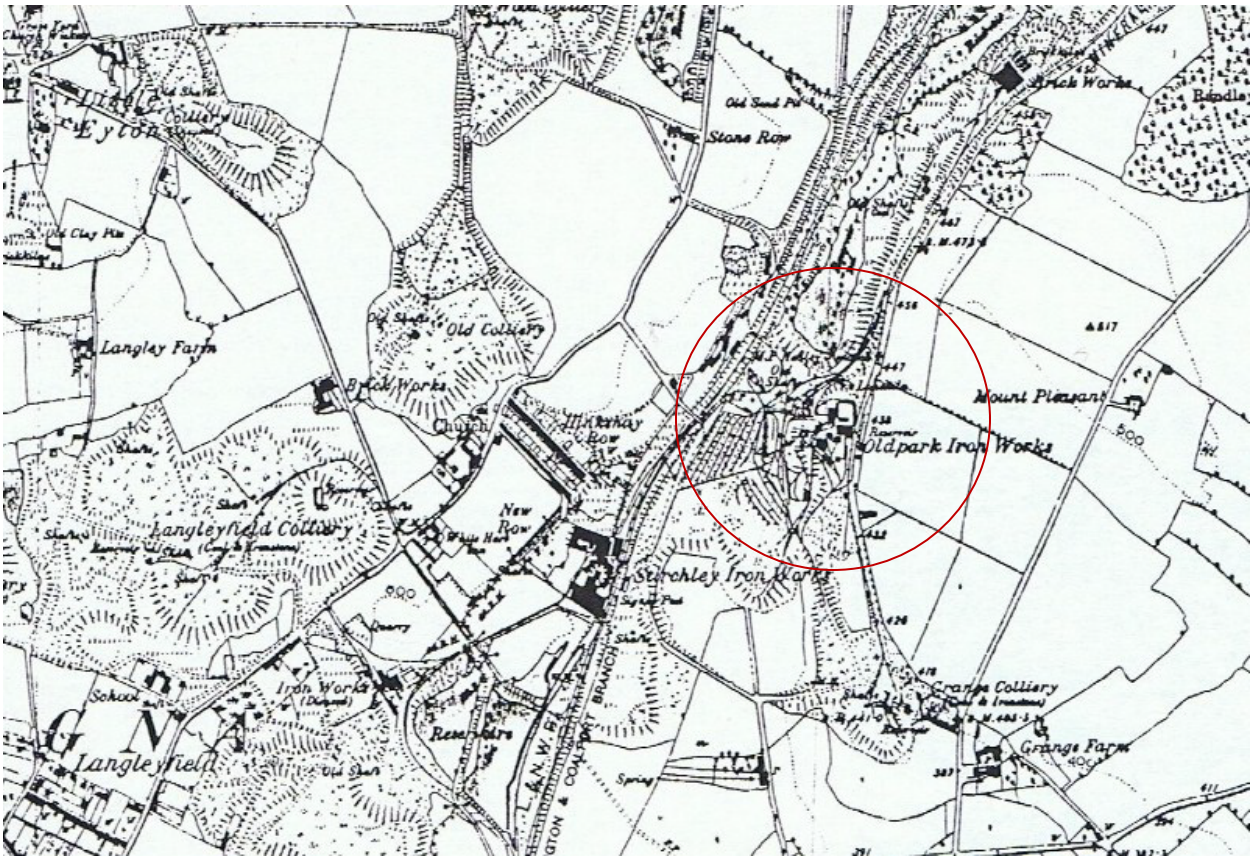

Fig. 7. Ordnance Survey Map, 1882.

By 1886 the former furnace site was leased to a timber merchant from Wellington named Thomas Groom. Groom was the inheritor of a family timber-business established in the 1830s, one of many in the town which made Wellington "the county's principal chair-making centre" (Baugh 1985, 222-232). With diverse interests, the Grooms were one of Wellington's leading families, and had established their 'Wrekin Chemical Works' in Limekiln Lane in 1883. They relocated to the derelict Stirchley site three years later, due to complaints about the smell (*Wellington Journal*, 30 August 1884). The chemical works extracted wood naphtha and tar from timber, and converted the residue into charcoal; they also manufactured acetate of lime and sulphur. Groom's successor, George Wilkinson, bought the site in 1904 and the works closed in 1932 (Baugh 1985, 222-232).

The slag heaps that had resulted from the furnaces activities were used as a source of raw materials for the manufacture of concrete and for road building from the late 19th century. H. C. Johnson established a slag-crushing plant by 1901, and bought the slag heaps in 1907. The concern was taken over in the 1920s by Tarslag Limited and the Bilston Slag Company Limited; the latter firm subsequently becoming part of Tarmac.

Concrete manufacturing ceased in the 1930s, and slag-crushing in the 1940s, although some slag continued to be removed from Stirchley until c.1964 (Baugh 1985, 222-232).

4.4 Stirchley and the development of hot blast

The successful application of hot blast was arguably the most significant development in iron making during the first half of the 19th century. Pre-heating the air before it entered the furnace enabled greater quantities of iron to be produced with less fuel. The method was well-suited to the Scottish ores and coals, and the conventional story of the development of hot blast revolves around the inventor James Beaumont Nielsen. Not an ironmaster, Nielsen proposed that greater efficiencies in ironmaking could be achieved by heating the blast to increase the amount of oxygen. After trials, Nielsen took out a broadly-worded 14-year patent in October 1828 (Smiles 1863). Others were, however, experimenting with similar methods. Welsh and American engineers were attempting to develop hot blast for use with anthracite from the mid-1820s (Eggert 1994). Indeed part of the success of Nielsen's method was due to the unsuitability of the Scottish coal for coking, and by using hot blast the Scottish ironmasters were able to use raw coal.

In England, ironmasters were also experimenting with hot blast for conventional coke-fired furnaces. It is possible, although unlikely, that John Wilkinson may have undertaken such experiments in the 1790s. What is certain, however, is that Thomas Botfield took out a patent on 2nd January 1828 for "causing or obtaining a blast of atmospheric air sufficient to smelt ... iron from ironstone or ore. The blast is to be produced by means of a rarified air, gas flame or heated air from an oven or fireplace ... [and] to use the atmospheric air either separate or mixed with gas flame or heated air" (Patent 5596, 2).

Nielsen defended his patent vigorously during its period of currency. This resulted in a series of long-running court cases, in which Nielsen claimed pre-eminence in coming up with the concept of heating the blast – as distinct from the many others who had developed specific methods.

One of these was Botfield, who was ruled not to have significantly pre-empted Nielsen's method (Corrins 1970). However it is clear from the wording of Botfield's patent that – although the detail of his method was different – the essential principle of heating the blast was being employed. Moreover by re-using waste gases, Botfield appears to have anticipated later developments. The fact that Botfield's patent appears to have been dismissed relatively lightly by the litigious Nielsen (and not re-contested by Botfield) suggests that it was perhaps not a huge success; nor was it immediately influential in new developments. The limited examination of the Botfield papers has not found any direct evidence for hot blast ovens being part of the original construction of the Stirchley site. However as early as 1825 "hard coals" were being used in the furnaces – a possible reference to anthracite, for which hot blast was essential.

Although it is not clear when hot blast was introduced to Stirchley – possibly after the date of the patent – it is clear that hot blast was firmly established at the site by the 1850s. This is in contrast to other local furnaces (such as the Madeley Wood Company's site at Blists Hill, the three furnaces at Madeley Court, the Coalbrookdale Company and the Lilleshall Company) which continued to use cold blast well into the later 19th century.

The hot blast process was quickly adopted elsewhere in the UK and throughout the world. As early as 1837, the French mineralogist Armand Dufrénoy noted that: "L'emploie de l'air chaud a produit en presque tous les établissments où il a été adopté, une économie plus ou moins grande; sur plus de deux-cents hauts-fourneaux où ce nouveau procédé est maintenant en usage...". He noted that around 120 of these more than 200 furnaces were in 'Angleterre' (although in practice he included Scotland and Wales in his calculations, with 65 in France, 10 in Belgium and 12 in the German provinces (Dufrenoy et al 1837, 382). Mushet, writing in 1840, also noted the widespread adoption of hot blast.

The improved efficiencies that hot blast brought to the manufacture of iron were accompanied by changes in the chemical composition of the metal. Cast iron produced by hot blast was generally higher in phosphorous and silicon, which made it good for remelting and casting in the foundry but not suitable for forge work. Indeed cold blast cast iron was perceived as better quality by forges until well into the 19th century.

The predominant method of forging iron during the period of the Stirchley furnaces was through puddling, which had been developed by Henry Cort in the 1780s. This involved the reheating of cast iron bars, piling the resulting bloom with a hammer and then passing the ingot through a rolling mill.

With the introduction of hot blast iron it was found necessary to introduce a 'refinery' as an additional stage. The refinery remelted the iron in a small 'snapper' furnace, itself provided with a blast (although usually unheated). This process removed silicon from the iron, and prepared it for use in the puddling furnace (David Cranstone, *pers. comm*.). By the 1860s, when most of the 'standard' accounts of puddling survive, the refinery had been dispensed with as the 'pig boiling' method became commonplace in the forge

Where the furnace and forge were separate entities, the refinery was located at the forge – where it could process iron from a wide range of sites. However where the forge was part of the same concern, and was located close by, the refinery was sometimes located with the blast furnaces. This enabled the refinery to use the same blast. This was the situation at Govan, near Glasgow, which was described in 1847 (David Cranstone, *pers. comm.*), and was also the case at Stirchley – where the Botfield's forge (Hinkshay) was less than half a mile away. That the refinery used the same blast is very clear from the 1856 description; this made good economic sense for a vertically-integrated concern such as that run by the Botfields.

5. THE STIRCHLEY FURNACES

The Stirchley furnaces comprise a partly buried structure containing two blast furnace stacks (although there were four furnaces known on this site). The furnaces are surrounded by a series of other features including the iconic Stirchley chimney, ore bins and other storage facilities, trackways, roads, and the foundations of other buildings. The whole is located within a complex of structures commonly known as the 'Stirchley chimney site', although historically more correctly identified as the 'Stirchley Furnaces'.

5.1 The Stirchley furnaces complex

The features described in this section are shown on Drawing 1. Stirchley furnaces are located at the northern end of the complex. They consist of two furnace stacks built into a single masonry structure which measures 21.7m north-south and 10.4m east-west (this is described more fully in 5.2 below).

The **western retaining wall** is located between 12 and 17 metres to the west of the furnaces. This was originally constructed of stone, and parts of the stone structure still survive; however the wall was later extensively rebuilt in brick. This brickwork is similar in style to that of the chimney (see below), which is dated 1872. The brick retaining wall incorporates a series of arches which formed part of the Wrekin Chemical Works kilns and furnaces. The furnaces are likely to have stood as tall as this retaining wall when built, and would have been charged from that upper level, which is referred to as the 'furnace bank' in the 1856 Valuation. The top of the bank would be reached by the 'incline' described in the 1856 Valuation, which presumably ran up the southern side of the present structure. The 1856 document also described the 'Coal Wharfs' at the furnace bank (together with their four weighing machines) and the 'Furnace bridge' with carriages for coal, ironstone and cinders. This latter item would refer to the gantries which extended from the top of this retaining wall out to the tops of the furnaces.

To the **north of the furnaces** the ground rises steeply, but also contains a number of depressions and other features. This is likely to be the area of the reservoirs and tanks noted in the 1856 Valuation. However overgrowth prevented a more detailed assessment of the surviving remains.

A **large tree-covered bank** is located between 10 and 12 metres to the east of the furnaces. This measures approximately 22m north-south and 11m east-west. Although the precise form of this bank has not been determined, it is possible that this does represent the location of the other pair of blast furnaces (see also below).

The eastern side of the site is bounded by the **former mineral tramway** (now a footpath), which is elevated above the main ground level on the site. Immediately adjacent to this, running along the eastern side of the site, is a series of structures which appear to include **storage bins** and other features. Again, overgrowth prevented a detailed assessment of these structures; however they include substantial masonry and brick-built walls, arches and revetments (see Fig. 9, on page 22). This would have been a logical location for the storage of limestone, ore and other materials which had arrived from further afield.

Fig. 8. View of the furnace complex from the north-west, looking south-east towards the Stirchley chimney from the furnace bank. Features noted in the text are labelled. See also Drawing 1, Appendix 2.

To the south of the furnaces is a complex arrangement of buildings and structures. These comprise both buildings associated with the later chimney, and features which were part of the original layout of the site in the 1820s. Indeed it seems likely that many of the features from the earlier (Botfield) phase were re-used and incorporated into the later remodelling of the site by the Wellington Coal and Iron Company. Features in this area will include:

- The **engine house** and **blowing house**. As noted above the 1856 valuation describes a Double Power Condensing Blast Engine, with 52-inch cylinder supplied by four boilers; this in turn powered the blowing apparatus with a 90-inch cylinder. The earlier accounts refer to more than one blast engine, but it is not clear whether this means more than one steam engine, or simply the distinction between the steam engine and the air blowing engine. The engines would have needed underground flues and pipes to supply water, circulate hot air and steam, and to contain the blast pipes leading to the furnaces and the refinery. The survey revealed a number of underground flues and chambers (Fig. 10, overleaf), and more are likely to survive within the structure itself.

Fig. 9. Features associated with the mineral tramway to the east of the site. Right: road leading between the engine house and the ore bins – the corner of the ore bin is marked by the ferns in the foreground. Left bottom: interior of one of the storage bins – the side wall is evident near the scale rods (note the line of the mineral tramway at the top of the photograph). Left top: detail of partly collapsed brick arch to one of the storage bins.

Fig. 10.Flues relating to the engine house and blowing house. Left: flue leading from the engine house to the chimney. Right: flue within the engine house area, oriented east-west, with evidence of heating and sooting to the interior.

- The force of the blast was controlled by a **regulator**, which was housed in a separate building in this area. The blast from the regulator was fed to both the hot blast stoves and the refinery.
- The **refinery**. The 1856 valuation suggests that the refinery is located approximately 27 metres away from the blast engine. Two blast mains are described: one to Nos. 1, 2 and 3 hot blast stoves supplying the furnaces, and one direct to the refinery (which also served No.4 hot blast stove). This arrangement probably resulted from the sequence of construction of the site, since Nos. 1, 2 and 3 furnaces were built first (in use by spring 1824), with the refinery first used in July 1824 and No.4 furnace only operational from the end of 1826.
- Blast pipes, water pipes and other channels.

The locations of the blast stoves have not yet been confirmed. However there are two possibilities for the arrangement of stoves and furnaces. One is that the stoves were located between the two pairs of furnaces, with casting taking place to east and west; the other is that the stoves were located around the 'outer' edges of the furnaces, with casting from all four furnaces taking place in a central casting house between the two pairs of furnaces. The lengths of the blast pipes (between 22 and 24 metres) suggest that they were wrapped around the furnace stacks.

Overall, the evidence of the site – together with the documentary evidence in the 1856 valuation – suggest the following probable layout of the site during the Botfield period:

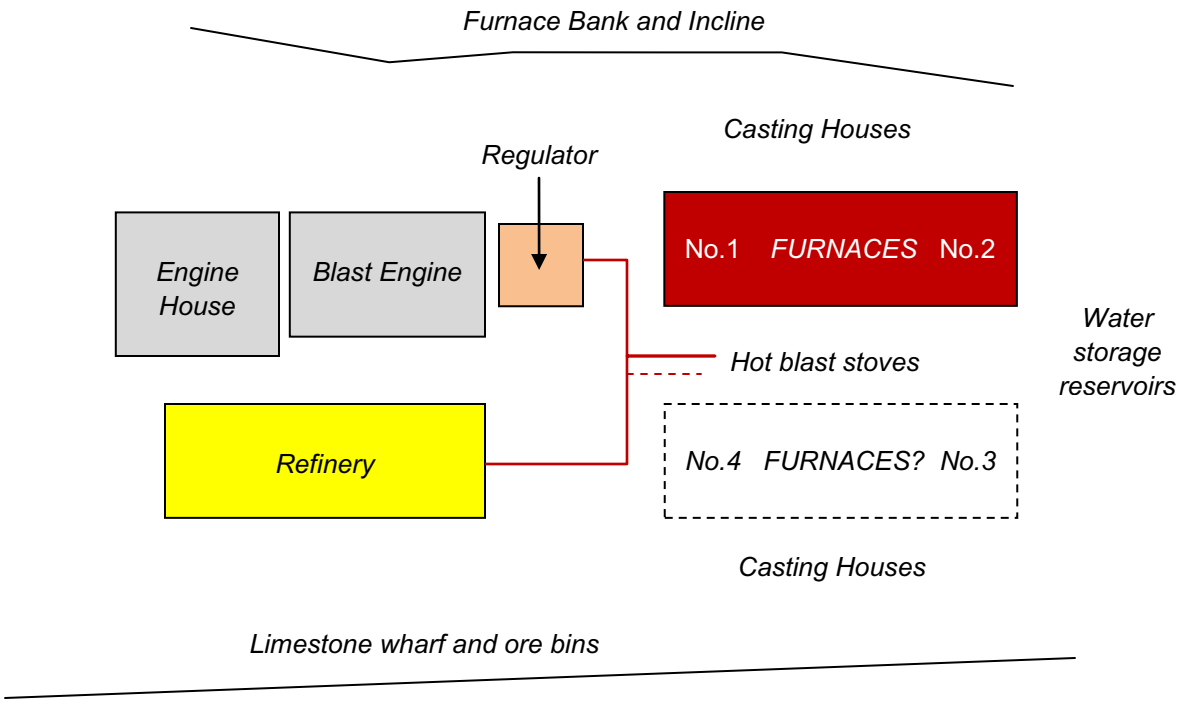

Fig. 11. Schematic provisional interpreted layout of the Stirchley furnace complex (not to scale), based on documentary and survey evidence. The furnaces shaded are those excavated during the present investigations. North is to the right.

5.2 The furnaces: standing building recording

As noted above, the furnaces were built as a pair, with a central passageway between them. The overall plan of the furnaces is shown in Drawing 2. The following description treats the pair of furnaces as a single entity, with reference being made to the north stack and south stack. The furnace structure was oriented north-south, originally measuring 21.74m long and 10.42m wide in plan. A brick extension was subsequently added to the south-western end of the furnace structure (see 5.2.5 below).

The furnace structure comprised five main structural elements, four of which relate to its original design, construction and use as a blast furnace:

- The external walls, built of sandstone blocks with brick detailing;
- Core of mixed brick, sandstone and rubble, bonded in lime mortar;
- The furnace stacks, built of firebrick;
- Structural ironwork, consisting of tie-rods and bars running through the structure;
- Later brick structures at the southern end of the furnace.

The maximum surviving height of the structure appears to relate to a change in its construction, from a square masonry structure which forms the base, to a pair of free-standing circular structures (ie. the furnace stacks) above. The extant and visible remains at the time of the building recording in fact comprised only the upper three or four metres of the structure. Excavation (see Fig. 2 above) revealed that the present ground surface was a further two or three metres above the original floor. In the following description, measurement of height is given from the ground surface at the time of recording, with estimates of the actual surviving height where appropriate. This aspect is discussed further in section 6, below.

5.2.1 **West-facing elevation**

This elevation is the best preserved of the longitudinal elevations (Drawing 3, and Figs. 12, 13, 14 and 15 below). It measures 20.30m north-south, and survives to a height of 3.70m above the present ground surface (6.60m above the original ground surface).

The northern part of the elevation is faced with coarse ashlar sandstone blocks up to a height of 5.60m above the original ground surface; above this is a (presumably truncated) area of diagonal brickwork which formed part of the furnace superstructure. The elevation was repaired with brick around the northern arch, and entirely rebuilt in brick to the south of the southern arch. This rebuilding of the south-western pier was undertaken in yellow firebricks laid in dark grey cement mortar in English bond. This work appears to have taken place during the life of the furnace. A further extension to the elevation was made when the furnace structure was in use by the Wrekin Chemical Company. This was completed in red engineering bricks, bonded in dark grey cement mortar in English bond (see also 5.3.1 below).

The western elevation incorporates three arches, all of which have brick surrounds and detailing.

Fig. 12. Overall view of the western elevation before excavation.

The northern arch measures 3.40m wide by 2.00m tall (although presumably stands 3.80 m high above the original ground surface) and serves the northern furnace stack. The collapse or removal of the ashlar stonework here made it possible to describe the internal details of construction. The arch is in fact made in two parts: an inner 'relieving' arch within the furnace structure, and an outer arch which is the brick-lined arch leading to the furnace itself (Fig. 13, overleaf). The inner arch consists of four courses of common bricks on edge, bonded with lime mortar. This is built into the rubble core of the furnace, and supports further brickwork above. Below this, the inner arch is constructed of two courses of firebricks on edge.

The central arch survives in a complete state of preservation (Fig. 14, overleaf). It originally provided a passage or walkway between the two furnaces, enabling both communication between the two sides of the furnace structure and allowing blast to be delivered to the south blowing arch of the northern furnace and the north blowing arch of the southern furnace. It is truncated by the collapse of the eastern part of the furnace structure (see 5.2.2 below), and is largely filled with demolition rubble. At the western elevation the arch is 1.20m wide and its apex is 2.70m above the original ground surface. The vertical side walls are of coursed sandstone, with the curved roof of the arch of firebrick.

The upper part of the southern arch (serving the southern furnace stack) had been almost completely removed by previous demolition and collapse (Fig. 15, on page 27). However enough survives in the lower parts of the elevation to determine that it is 4.10m wide; it presumably originally stood to the same height as its northern counterpart. The northern side of the arch has been rebuilt in red common brick. The eastern corner is also of brick, and, as noted above the remainder of the elevation to the south of this arch is of brick.

Fig. 13. Western elevation: northern arch. Right: detail of the construction of the wall behind the ashlar facing. Top left: detail of the outer arch and brickwork above; the keystone of the arch is at the right-hand edge of the photograph. Bottom left: the arch as revealed during excavation.

Fig. 14. Western elevation: central arch. Left: the full extent of the arch as revealed by excavation; the dark stain indicates the level of the ground surface prior to excavation. Right: detail of the firebrick arch and ashlar sides of the access tunnel.

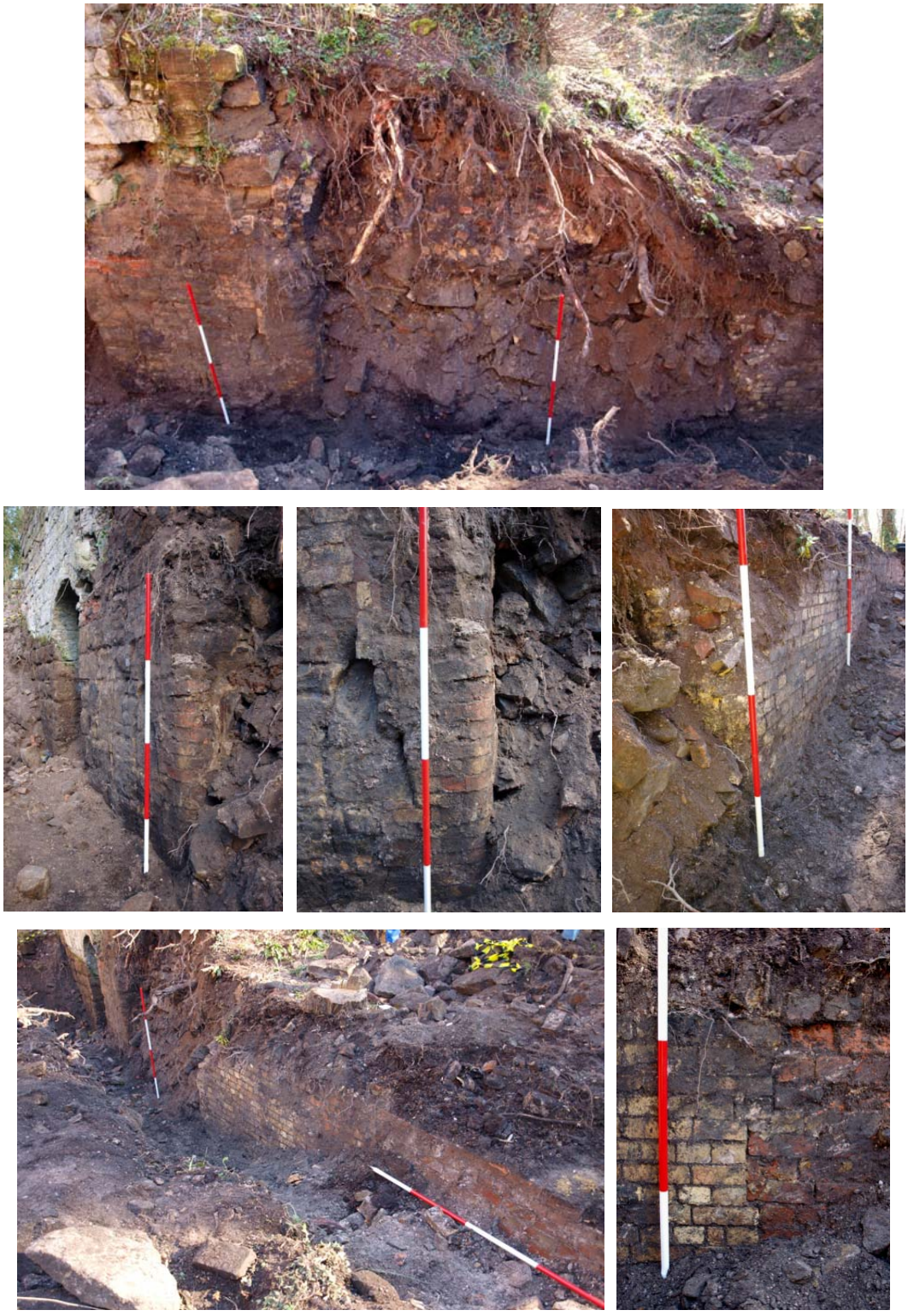

Fig. 15. Western elevation: southern arch and south-western pier. Top: Overall view of the arch (the right-hand scale rod is in the centre of the rubble-filled arch). Middle left: the northern side of the arch, looking north towards the central arch. Middle centre: detail of the brick repair to the northern side of the arch. Middle right: the southern side of the arch, with firebrick rebuild beyond. Bottom left: view of the south-western pier showing the firebrick rebuild and later brick extension. Bottom right: detail of the change in brickwork between the original pier and later extension.

5.2.2 **East-facing elevation**

The original form of this elevation reflected that of the western elevation, but was truncated above the level of the tops of the arches (Drawing 4, and Figs. 16 and 17 below). It measures 21.70m north-south and survives to a height of 2.2m.

The surviving elevation is faced with coarse ashlar sandstone blocks. The eastern elevation is patched in places with brick, although less extensively than its western counterpart. It incorporates three arches, two of which retain part of their brick surrounds and detailing.

Fig. 16. View of the eastern elevation from the north-west corner, with the northern elevation in the right of the photograph.

The northern arch measures 3.30m wide by 1.80m tall (although presumably stands 3.80 m high above the original ground surface) and serves the northern furnace stack. Although severely truncated in height, the eastern elevation retained most of its ashlar facing. The firebrick-lined inner arch, and detail to the elevation itself does survive, albeit considerably distorted from its original shape.

The central arch originally provided communication between the two furnaces and between the two sides of the furnace structure. However on the eastern side of the furnace this has been truncated by collapse. Consequently although the ashlar side walls survive, the firebrick-arched roof does not. However it is likely to survive within the furnace structure, although it was not possible to determine the extent of this during the present fieldwork.

Fig. 17. Eastern elevation: north and central arches. Left: view of the northern arch after excavation, showing the relationship between it and the northern furnace stack (note also the retaining wall in the background). The ground level here is approximately 1.5 metres above the original ground surface. Right top: view looking north-west from the central arch (the north edge of which is visible at the left of the photograph) with the northern arch in the background. Right bottom: the central arch.

The southern arch of the eastern elevation (ie. the eastern arch of the southern furnace) had been largely demolished, but clearance and excavation (see also 5.3.4 below) revealed that the northern side survived to a height of 1.20m. The area between the southern and central arches needed to be partly reduced for safety reasons, as tree root damage and erosion had caused a void to appear in this part of the structure. However the lower part of this northern elevation of the southern arch was retained.

This elevation [1002] was primarily of ashlar sandstone blocks, but included a former opening. This (Fig. 27, in section 5.3.4 below) was 0.50m wide and 0.75m tall; it was surmounted by a cast iron lintel or plate and had been blocked by firebricks [1004]. This is a continuation of the internal flue noted in the south-eastern pier during archaeological excavations (see 5.3.3 below).

This interior of this arch was floored in common brick set in an irregular pattern [1005]; this was a later alteration associated with the Wrekin Chemical Works phase (see also below) which would appear to have raised the ground level by approximately 1.0 to 1.5 metres.

To the south of the southern arch the elevation was completely destroyed above the present ground level; however it was traced during excavation (for full description, see below). The original elevation had consisted of ashlar stone blocks, with a later brick extension to the south.

5.2.3 **North-facing elevation**

The north-facing elevation was almost entirely buried; however excavation revealed that it survives in an excellent state of preservation immediately below the present ground surface (Drawing 4, and Fig. 18). It measures 10.40m east-west, and stands to an original height of 4.60m above the original ground surface. Only 1.50m of height was exposed during fieldwork, due to the instability of the slope to the north.

The north-facing elevation incorporates a large brick-lined arch, which served the north side of the northern furnace stack. This appears to be very similar in construction to the other large arches, and is the best-preserved. It measures 3.20m wide, and is lined with two courses of firebrick on edge.

Fig. 18. Northern elevation. Left: view along the northern elevation from the north-east corner of the furnace structure. Right top: detail of the arch as visible on the external elevation. Right bottom: the interior of the arch. Note the soot-blackened brickwork and the rubble at the end which is contained within the northern furnace stack; minor distortion of the arch is also apparent, even though this is the best-preserved of all the outer furnace arches.

5.2.4 **The furnace stacks**

As noted above, the maximum surviving height of the structure appears to relate to a change in its construction, from a square masonry structure which forms the base, to a pair of free-standing circular structures (ie. the furnace stacks) above. The lowest courses of the curved outer wall of the upper structure to the northern furnace were observed after vegetation clearance (Fig. 19).

Fig. 19. Curved masonry wall at the interface between the furnace structure and superstructure. Left: view of the southern elevation of the northern furnace outer wall, looking north. Right: view of the north-eastern elevation of the northern furnace outer wall, looking south-west from the north-eastern corner of the furnace structure.

The interior of the stack is formed from firebricks, which show extensive corrosion and vitrification as a result of the use of the furnace; there has also been movement of the furnace walls so that the profile is irregular. This is shown in Drawing 6.

The northern stack is partly filled with rubble from its own demolition and collapse. It survives to a maximum observed height of 4.10m, although the maximum surviving height from the original base of the stack is likely to be around 6.50m. The south, west and north parts of the circumference survive in a good state of preservation (see also the southern stack, below). However the eastern side of the northern stack has collapsed. It seems likely that this was a failure during the working life of the furnace. There are two possible explanations. The first is that furnace had been worked hard, resulting in the lining being weakened at this point and collapsing on cooling after the final campaign. The second is that this was a catastrophic failure during the smelting process itself. This latter interpretation seems less likely, as no contemporary accounts have been identified which suggest that any sort of accident took place at Stirchley during the 1880s.

The southern stack is in a much poorer state of preservation, and was only identified after clearance and excavation work (Figs. 28 and 29, and Drawing 6). The eastern side survives to a height of 3.50m, with collapse to the west, south and north sides. The interior of the stack [1001] is formed from firebricks, which show extensive corrosion and vitrification as a result of the use of the furnace; there has also been movement of the furnace walls so that the profile is irregular.

5.2.5 **Structural ironwork**

The furnace structure incorporates a great deal of structural ironwork. This principally comprises a series of wrought-iron tie-bars which run east-west and north-south through the masonry of the furnace. These bars are roughly square in section measuring between 20 and 30mm across. They are secured to the outer walls with cast-iron plates (Fig. 20).

Fig. 20. Structural ironwork. Top left: wall-tie plate on the western elevation. Top right: wall-tie plate on the eastern elevation. Bottom left: lateral and longitudinal bars exposed by the partial collapse of the eastern elevation to the north of the south arch on that side. Bottom right: detail of lateral bar in the same location.

5.2.6 **Later additions and modifications**

The southern part of the furnace structure was extensively modified when the site was being run by the Wrekin Chemical Works. This work included a brick extension to the south-west pier, strengthening of the south arch, and new floor levels in the south and east arches of the southern furnace. This is described more fully below.

5.3 The furnaces: archaeological excavation

Archaeological excavation took place at the southern end of the furnace structure, in order to clear and more fully understand this area which had suffered extensive collapse. The excavated area measured 8.50m north-south by 12.0m east-west, and included the south-western pier, the southern arch, the south-eastern pier and the eastern arch (Drawing 5, and Fig. 21).

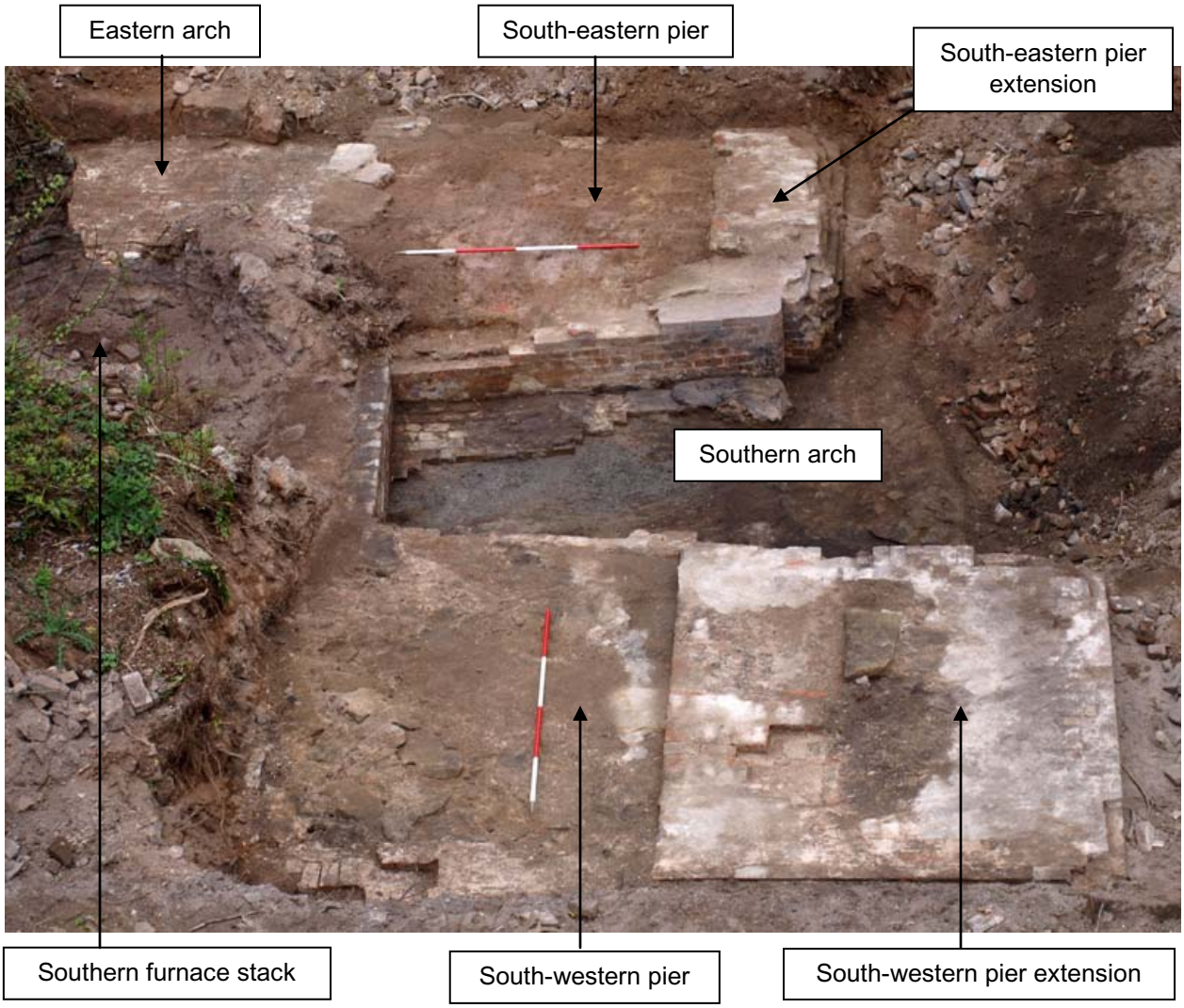

Fig. 21. Overall view of the excavated area, looking east from the top of the retaining wall, showing areas and features mentioned in the text.

5.3.1 **The south-western pier**

As noted above the south-western pier had been rebuilt and extended. Rebuilding took the form of re-facing the western elevation in firebrick [1030] during the life of the furnaces. The internal structure of the pier [1015] was unaffected. It consisted of large sandstone blocks with rubble fill (incorporating some brick inclusions), bonded with a hydraulic lime mortar.

The extension [1014] comprised a solid brick platform, measuring 4.0m east-west and 3.20m north-south and effectively adding 3.0m on to the length of the western elevation. The platform was constructed of red engineering bricks, and incorporated a stone block [1013] towards the centre. As excavated, this platform appeared to have been truncated below the original floor level; however it is possible that this stone block was intended as a machine base just below the floor. However no holding-down bolts were evident.

Associated with this extension was the addition of a brick lining [1011] to the western wall of the southern arch. This is described below (5.3.2).

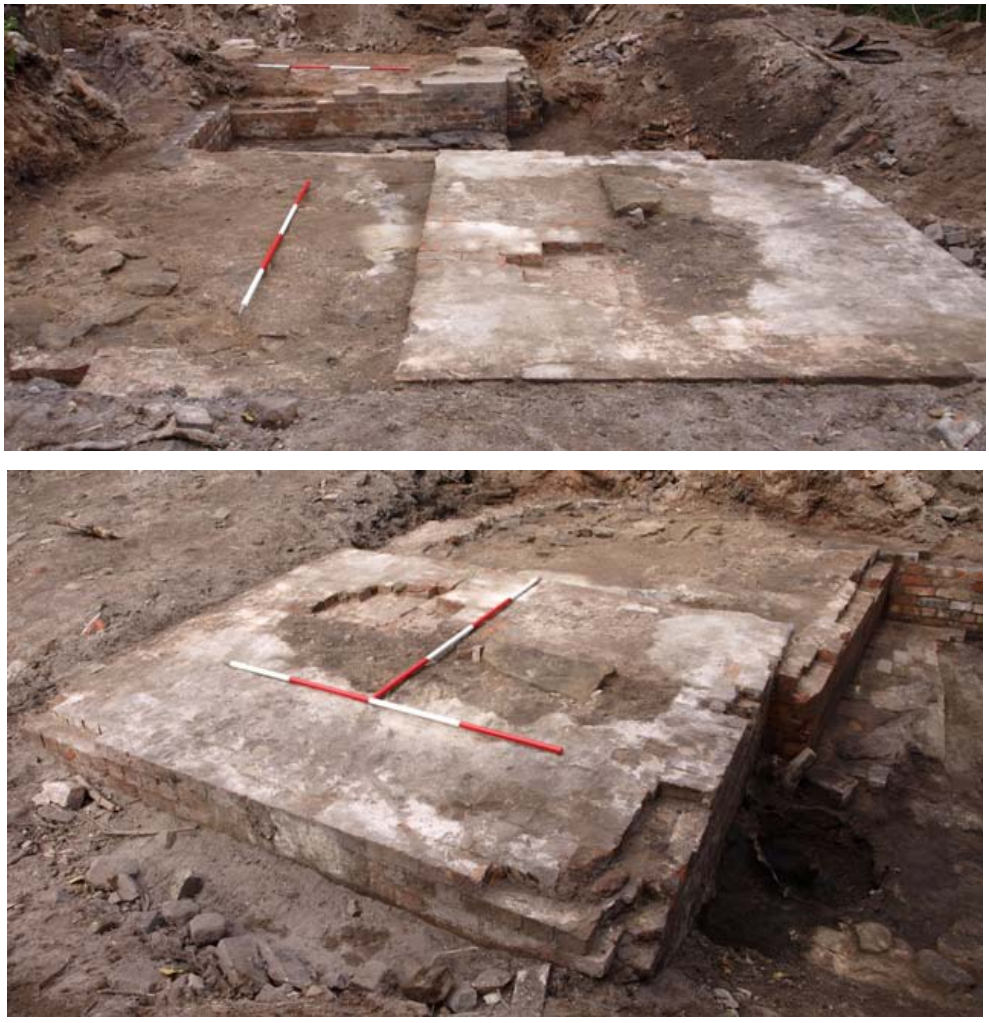

Fig. 22. The south-western pier and its extension. Top: view from the west showing the original pier (left) and the extension (right). Bottom: view from the south, showing the south elevation of the extension and the addition of a brick 'lining' to the interior of the southern arch. See also Figs. 23 and 24 below.

5.3.2 **The southern arch and associated features**

The southern arch survived to a height of 0.65m above the present ground surface. Although the basic outline of the original arch was evident in plan, its precise form had been modified by later additions and insertions during the Wrekin Chemical works phase. It tapered slightly in plan, measuring 2.90m across (ie. east-west) at the southern end, and 2.10m across at the northern (furnace stack) end.

A brick wall had been built around the interior of the arch, effectively providing a façade to the eastern [1009] and western [1011] elevations, and blocking access to the furnace stack [1012]. This was built of red engineering bricks bonded in grey cement mortar using English bond. The southern ends of [1009] and [1011] incorporated rounded-arris bricks where they joined with the southern extensions (see 5.3.1 above and 5.3.3 below). Abutting these refaced walls were two brick floors running down the east [1017] and west [1016] sides of the arch. These were constructed of re-used materials salvaged from the furnaces, including common bricks, firebricks and large furnace-lining bricks. The floor surface was worn, and partly covered with tar deposits [1031]. These brick floors were bedded on a dark grey clay [1024] which also extended southwards beyond and 'outside' the arch.

Within the arch, the grey clay [1024] was overlain by a grey-black loose cindery fill [1023]. This appeared to represent a floor surface or make up layer that was broadly contemporary with the brick floors between which it was situated.

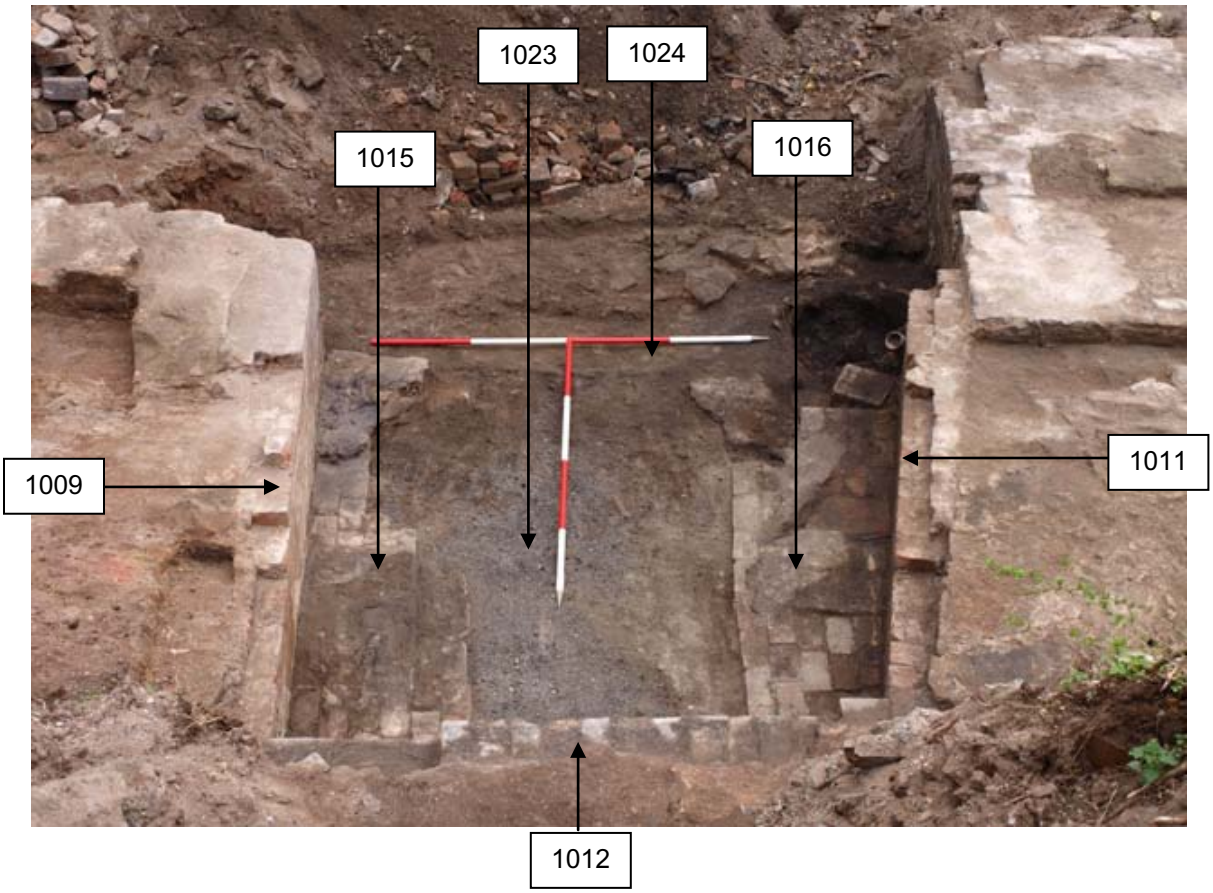

Fig. 23. The southern arch, overall view looking south from the top of the southern furnace stack.

Three features were located outside the arch. The first was located at the south-western corner of the arch, and comprised a wrought-iron barrel or cylinder [1018], 0.80m in diameter, which had been sunk into the ground [1024]. This had a 100mm diameter cast-iron pipe [1019] running vertically up through the centre. A circular wrought iron plate with a 100mm diameter central hole was recovered during machine clearance; this would appear to have been the lid of this apparatus. The barrel itself was filled with a dark-black tar-rich silt [1020]. The presence of tar and the potential for contamination by the by-products of the chemical works meant that the excavation of this feature was confined to cleaning, recording and sampling. Therefore it was not possible to determine the original depth of the apparatus. Another length of 100m cast-iron pipe [1021] was noted immediately north-west of the barrel [1018]. One excavation this was found to be *ex situ*. Overall this feature appears to have been some sort of distilling or heating apparatus, and possibly the *ex situ* pipe [1021] had originally served as an above-ground outlet for the vertical pipe [1019].

The second feature outside the arch was a deposit of small sandstone rubble to the south of the arch [1022]. This extended under the edge of the excavated area, and it was not possible to determine whether this was a collapsed wall or spread of demolition rubble.

The third feature was roughly-built brick wall, oriented east-west [1033]. This was made of re-used common bricks and firebricks, and appeared to represent a partition between the interior and exterior working spaces of the arch. It was bedded directly on [1024] and was abutted by [1023].

Fig. 24. The southern arch. Left: view looking north-west showing the location of the barrel [1018], with wall [1033] beneath the scale rod, and floor surfaces [1015] and [1016] evident behind. Right: detail of the barrel [1018] with the central pipe [1019] and the external pipe [1021].

5.3.3 **The south-eastern pier**

The south-eastern pier [1006] consisted of large sandstone blocks with rubble fill (incorporating some brick inclusions), bonded with a hydraulic lime mortar. The north, east and west sides of the pier were ashlar faced; it was not possible to determine the nature of the original southern face as a result of later truncation (see below).

Fig. 25. The south-eastern pier. Top left: view prior to cleaning, looking south-west showing the relationship with the southern arch; note the brick blocking of the former flue. Top right: view from the south showing the later extension. Middle: view after cleaning from the interior of the southern furnace stack (compare with Fig. 28, below), showing the arc of the (blocked) flue [1007]. Bottom: views of the flue after partial removal of later blocking.

Within the pier was a stone-lined flue [1007]. This measured 0.50m in average width, and ran in an arc from the southern wall of the eastern arch (see below) to the eastern wall of the southern arch. Originally this flue had been lined with stone blocks, and formed part of the original construction of the furnace. There was extensive sooting to the interior of the flue. The flue had subsequently been comprehensively blocked [1032] with re-used firebricks set in a very hard cement mortar/concrete mixture. This blocking appears to have taken place after the furnace went out of use. Similar blocking was noted in the northern wall of the eastern arch (see 5.2.2 above and 5.3.4 below).

As noted above the south-eastern pier had been extended. The extension [1008] comprised a solid brick platform, measuring 3.50m east-west and 1.10m north-south and effectively adding 1.0m on to the length of the eastern elevation. The platform was constructed of red engineering bricks, and appeared unfinished on its southern side, with an irregular elevation and numerous protruding bricks. As excavated, this platform appeared to have been truncated below the original floor level.

Associated with this extension was the addition of a brick lining [1009] to the eastern wall of the southern arch. This is described above (5.3.2).

5.3.4 **The eastern arch and associated features**

The eastern arch retained its original form and size in plan. It measured 3.30m across (ie. north-south) at the eastern elevation, and 2.20m across at the western (furnace stack) end. The internal elevations (north and south) consisted of ashlar sandstone blocks. That on the north side [1002] incorporated a former opening (Fig. 26). This was 0.50m wide and 0.75m tall; it was surmounted by a cast iron lintel or plate and had been blocked by firebricks set in a hard cement mortar/concrete [1004].

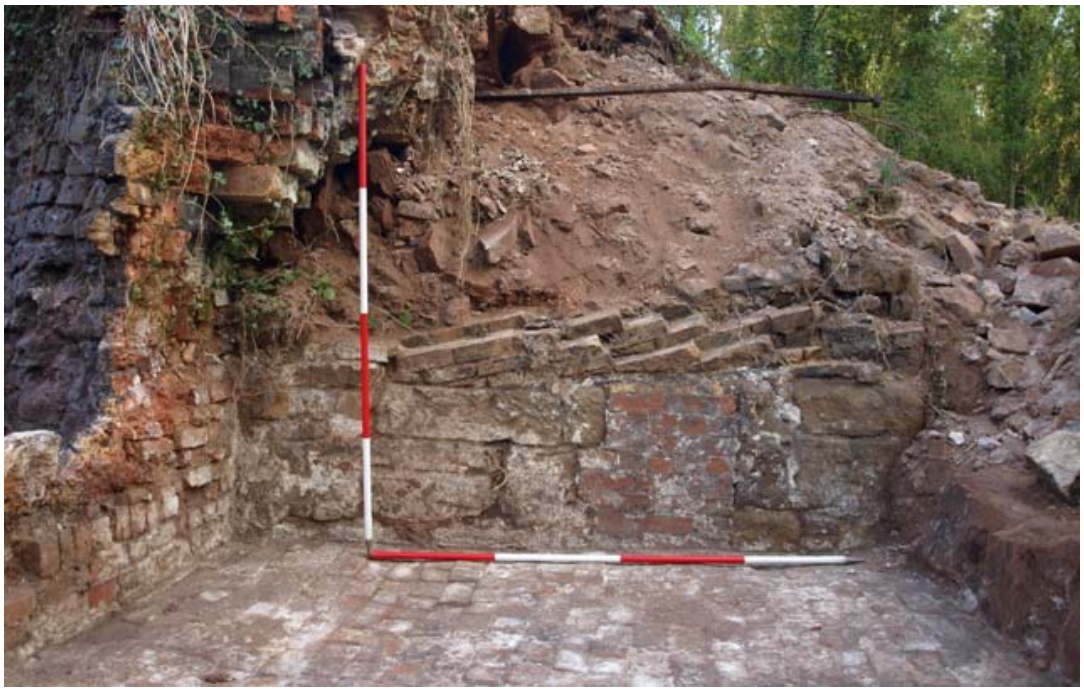

Fig. 26. The eastern arch. Elevation of the northern wall, showing the blocked former flue [1004].

The southern elevation (comprising the north-facing elevation of the south-eastern pier [1006] was badly truncated, but the same basic arrangement was evident. The brickwork [1004] in the north wall, and the blocked flue [1007/1031] in the south wall are effectively a continuation of the same internal flue which would originally have run around the interior of the furnace stack (for comparison with documented examples, see Figs. 30 and 31 below).

Fig. 27. The eastern arch. View showing the later brick floor and wall [1025].

Later modifications included the insertion of a brick wall at the western end of the arch. This wall [1025] was constructed of re-used firebricks and blocked the original furnace opening [1026]. Following the construction of this wall [1025] and the blocking of the flues ([1004] and [1007]), the ground level was raised and the interior of the arch was paved using in common brick set in an irregular pattern [1005]. Later still a dry stone wall [1010] was built to block off the arch altogether. This was oriented north-south, blocking the eastern end of the arch; it was built of re-used sandstone blocks.

5.3.5 **The furnace stack**

The southern furnace stack was partly excavated. All four former arches were revealed. The north and west arches had partially collapsed, and the south arch had been demolished and blocked with wall [1012]. The eastern arch, although blocked by wall [1025], survived in a reasonable state of preservation.

The base of the furnace retained its 'bear' – namely base of a blast-furnace hearth which has become impregnated with slag and/or metal during the life of the furnace (Morton and Wingrove 1969). This effectively limited the extent of hand excavation. However sufficient was excavated to ascertain that this appeared to be the 'tapping arch' of the southern furnace.

The arch itself [1026] was lined with grey clay which had become reddened during the heating process. The heat had also distorted the lining of the furnace in this area (see Drawings 5 and 6).

Fig. 28. The southern furnace stack. View of the interior of the stack looking south-west. The eastern (tapping) arch is clearly visible in the left foreground; the southern arch has been completely destroyed. Note also the south-eastern pier in the background, and the later walls to the southern arch and floor in the eastern arch.

Fig. 29. The southern furnace stack. Detail of the tapping arch showing clay lining and 'bear' in situ*.*

6. DISCUSSION

On the basis of the limited documentary research, it would appear that the recorded furnaces were Nos. 1 and 2 furnaces, with No.1 to the south and No.2 to the north. However this is not certain. It is clear that extensive remains of the furnaces and associated structures are likely to survive in a good state of preservation approximately 2-3 metres below the present ground surface

6.1 Construction and operation of the furnaces

The Stirchley furnaces appear to have consisted of a square masonry base, constructed to a height approximately 6.5m above the original ground surface, surmounted by a cylindrical or conical masonry superstructure. The furnaces were built in pairs, with a central passageway. In this they differ from other known Shropshire examples, which tended to be built as single furnaces. The Blists Hill furnaces of the Madeley Wood Company, for example, were built in the 1830s and 1840s and consist of three adjacent but structurally separate bases. The structural form of the Stirchley furnaces more closely parallels that of the Black Country. Andrew Ure, writing in 1843, described "the blast furnaces of Staffordshire" thus:

"Their outer from is frequently a cone, often also a pyramid with a square base. They are bound about with a great many iron hoops, or with iron bars placed at different heights... They are seldom insulated; but are usually associated to the number of two or three in the same line. A narrow passage is left between them, which leads to the lateral openings where the tuyeres are placed..." (Ure 1843, 658-659).

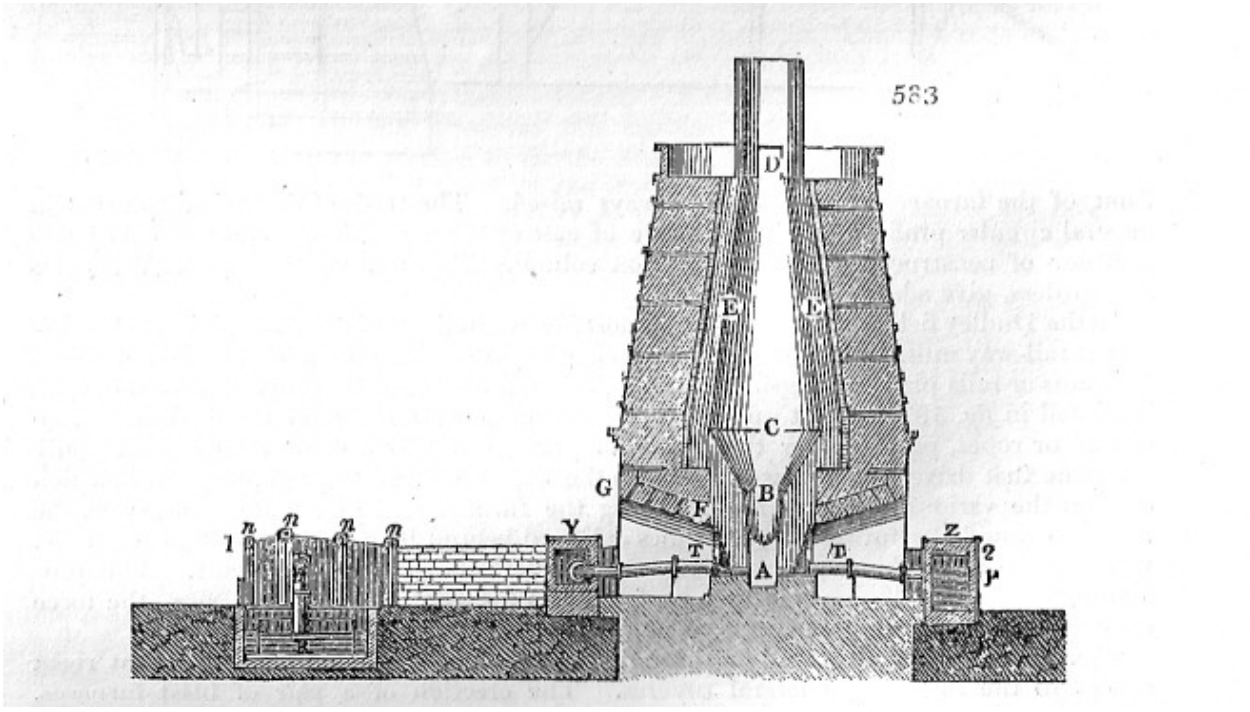

Fig. 30. Cross-section through a typical 1840s hot-blast furnace of 'Staffordshire' type (Ure 1843, 690).

This arrangement enabled them to be blown from three sides, with the molten iron and slag tapped from the fourth side. The limited documentary and archaeological evidence suggests that the surviving Stirchley furnaces were tapped from the east side – although this would need to be confirmed with further research and excavation.

It is known that hot blast was being used in the 1850s, but on the evidence of the limited study of documentary sources it did not appear to have been introduced during the 1820s. Botfield's patent of 2nd January has been discussed above; it required a single hot blast stove for each furnace. The draught was enhanced by a supplementary chimney running up the outside of the furnace stack, which drew the flow of air across the hearth. The addition of the chimney was different from what later became standard practice, and in fact may not have worked particularly effectively. However there is some evidence to suggest that the Botfield method was attempted in practice at Stirchley, both from the documentary sources and from the structure itself.

The Botfield accounts record repeated repair and replacement of blast engines, suggesting a period of experimentation. Is it possible that the engines originally installed were intended to work with Botfield's chimney, but when this method didn't work it was found that more powerful engines were required? More tellingly, in November and December 1828, Thomas Jones was paid for work at No.1 furnace, which included repairs to the "Tunnel head", "taking down and rebuilding a chimney" and building a wall "to keep cinders from Air Furnace" (JRL: BOT 2/31/2). The area of missing masonry on the western side of the northern furnace would correspond closely with the location of an external supplementary chimney as depicted on Botfield's patent. If such a chimney had been built into the furnace and then later removed, its former location would have left that part of the structure in a weaker condition. Finally the ground plan of the southern furnace, with its internal flue (later blocked) is identical to that of slightly later hot-blast furnaces (Fig. 31).

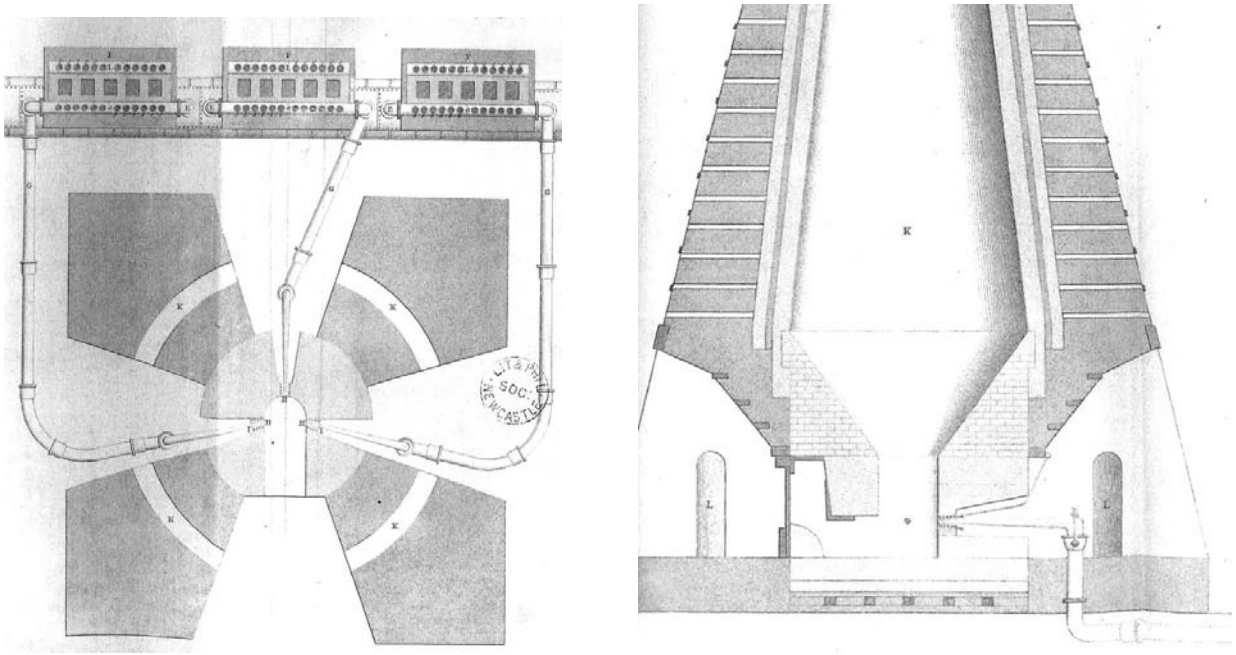

Fig. 31. Plan and section of a hot blast furnace of c.1840 (Mushet 1840, 925-928).

Further research and site work needs to identify the locations of the later hot blast stoves, and then to determine when they were originally constructed – and what arrangement may have been in place beforehand.

The Botfield accounts suggest that most of the raw materials for the construction of the Stirchley furnaces came from their own mining and brickmaking operations. None of the early bricks (such as those incorporated into the structures of the various arches around the furnace) are stamped or marked; all are unfrogged hand-moulded firebricks. The original furnace lining has not survived, since this would have been regularly repaired and renewed. It is therefore not surprising that only the lining from the latest phase of iron smelting operations is represented in quantity. These firebricks are stamped 'Harris and Pearson'. The Harris and Pearson company was established in 1852 and was at its peak of production in the 1870s, with exports to blast furnaces as far away as Lake Oswego in Oregon, USA (built in 1865) and Lal-Lal in Victoria, Australia (built in the 1880s). It therefore seems likely that these firebricks – and consequently the final form of the interior of the furnaces themselves – date to the post-Botfield period.

The proximity of the refinery is, as noted above, unusual. A comparable contemporary example comes from the Govan Iron Works near Glasgow. Here the refining process was "performed in close juxtaposition with the smelting furnaces, the same blasting-engine supplying the blast-air in both cases simultaneously" (David Cranstone, *pers. comm.*.). The Botfield accounts record the construction and operation of the refinery in some detail.

6.2 The post-ironworks use of the Stirchley site

After the closure of the ironworks the furnaces were truncated to the level of the top of the square sub-structure – that is to say their present maximum height. This would have taken place at, or around, the time the site was taken over by the Wrekin Chemical Works.

Modifications made to the site during the Wrekin Chemical Works phase appear to have left the blast furnaces relatively undamaged. Major modifications were made to the western retaining wall on the site to create kilns for the chemical works; and some alterations were made to the southern furnace. These included the strengthening of the southern arch, and extensions of the two southern piers. The internal flue was also blocked at this stage. These and other modifications were made using firebricks salvaged from the demolition of the furnace superstructure. The remaining rubble from the demolition process was spread around the site. Indeed, the Wrekin Chemical Works modifications appear to have raised the ground level around the furnaces by up to 1.5m.

It is possible that the truncated furnace stacks themselves were used for charcoal burning. However such an activity would have taken place at a much reduced temperature from iron-smelting operations, and would have left no detectable chemical signature in the furnace lining (David Dungworth, *pers. comm*.). Other specifically ironworking structures – such as the refinery – were probably demolished during this period; however the engine house and other features (which presumably could find a new use as part of the Chemical Works) were retained.

An aerial photograph of the mid-twentieth century (Fig. 32) shows the boiler house, engine house and some of the other ancillary buildings still standing. The ore bins are also clearly depicted. The northern furnace appears to have had a building erected on top of it. The extensive slag heaps surrounding the furnace complex are also evident, as is their encroachment on the earlier, pre-nineteenth century landscape.

The engine house, boiler house and other features were subsequently levelled by Telford Development Corporation. The furnaces, however, perhaps because they were already partly demolished and partly buried, were left untouched.

Fig. 32. A mid-twentieth century aerial photograph of the Stirchley furnaces site. The chimney is clearly visible centre-left. The low building to the north-west of the chimney is probably the former boiler house; the tall building behind that is the former engine house. The furnaces are behind the engine house; the white square appears to be a new structure built on top of the north furnace stack. This photograph also shows the ore bins to the right (east) of the engine house. Photograph supplied by Malcolm Peel of the Dawley History Group, and used with kind permission.

6.3 Ground conditions and assessment of preservation

The results of the Nexus Heritage investigations, together with earlier work on the site by K&M Construction, suggests that the present ground level is up to three metres above the original working ground surface of the ironworks complex.

This build up of material appears to have been greatest at the northern end of the site, tapering off around the chimney. As a result the original ground level of the furnaces is approximately 3.5m below the present ground surface at the northern end of the furnace structure, and approximately 2.5m below the present ground surface at the southern end.

As noted above this process partly began with the Wrekin Chemical Works, the managers of which appear to have arrange for the demolition rubble to be used both to modify existing structures and to create new ones; they also raised the ground level by approximately 1.5m. The clearest evidence for this is in the eastern and southern arches of the southern furnace, where the brick floors are respectively 1.52m and 1.45m above the presumed original floor level of the central passageway.

The ground level around the furnaces was subsequently further raised by the Telford Development Corporation, with some landscaping around the southern end. A photograph of the furnaces at around this time is shown in Fig. 33; this shows the structure remained reasonably solid.

Fig. 33. The furnaces in the 1960s. The ground level is only slightly lower than in 2011. However the superstructure survives in much better condition. There is much less ashlar missing from the northern furnace, and the top course of stone (with brickwork above) is largely intact. Photograph supplied by Malcolm Peel of the Dawley History Group, and used with kind permission.

It seems likely that the remains of the boiler house, engine house, blowing house, regulator, hot-blast stoves and refinery survive in a good state of preservation. Indeed substantial structural remains of what are likely to be the boiler house, engine house and blowing house are evident above ground in the southern part of the site; and these are likely to extend up to two metres below the present ground surface.

7. STATEMENT OF SIGNIFICANCE

In order to provide an objective analysis of the significance of the site, the Stirchley furnaces have been assessed against the following Scheduling criteria deployed by English Heritage:

- **Period:** all types of monuments that characterise a category or period should be considered for preservation.
- **Rarity:** there are some monument categories which are so scarce that all surviving examples which still retain some archaeological potential should be preserved. In general, however, a selection must be made which portrays the typical and commonplace as well as the rare. This process should take account of all aspects of the distribution of a particular class of monument, both regionally and nationally.
- **Documentation:** the significance of a monument may be enhanced by the existence of records of previous investigation or, in the case of more recent monuments, by the supporting evidence of contemporary written or drawn records.
- **Group Value:** the value of a single monument may be greatly enhanced by its association with related contemporary monuments or with monuments of different periods.
- **Survival / Condition:** the survival of a monument's archaeological potential both above and below ground is a particularly important consideration and should be assessed in relation to its present condition and surviving features.
- **Fragility / Vulnerability:** highly important archaeological evidence from some field monuments can be destroyed by unsympathetic treatment; there are also existing standing structures of particular form or complexity whose value can again be severely reduced by neglect or careless treatment, and which are similarly well suited by scheduled monument protection.
- **Diversity:** some monuments may be selected for scheduling because they possess a combination of high quality features, others because of a single important attribute.
- **Potential:** on occasion, the nature of the evidence cannot be specified precisely, but it may still be possible to document reasons anticipating its existence and importance and so to demonstrate the justification for scheduling. The greater the likelihood that such evidence will be revealed through archaeological investigation, the stronger will be the justification for scheduling.

The significance of the Stirchley furnaces site under each of these criteria is ranked as follows: very high, high, medium, low or none.

Period: **LOW**. The Stirchley furnaces were in use for smelting iron from 1824 until 1883, and subsequently used by the Wrekin Chemical Company to the mid-twentieth century. Numerous monuments survive of this period. However Stirchley represents an archaeologically complete example of an early nineteenth century hot blast iron smelting site. Later use of the site has to a large extent preserved its original form.

Rarity: **VERY HIGH**. No other furnaces of the same type and date are believed to be extant in this condition in the same condition regionally. Their association with a refinery is also rare, and they also represent the only extant remains of furnaces associated with the influential Botfield concern. Moreover the furnaces may represent a very early, and unusual, experiment with the hot blast process. They are therefore unique.

Documentation: **VERY HIGH**. The Stirchley furnaces are associated with a large archive of primary documentation that is only partly catalogued; nevertheless the Botfield papers at the John Rylands library contain a wealth of detailed documentation about the construction and operation of the site.

Group value: **HIGH**. The Stirchley furnaces survive within a complex of associated features, including engine house, blowing house, storage and transport facilities, hot blast stoves, casting houses and a refinery. Other related features survive in the immediate landscape, such as the mineral tramway, slag heaps, the Hinkshay forge, and workers' housing at Hinkshay. The association with the Botfield family is also important.

Survival/condition: **HIGH**. The Stirchley furnaces survive to a height of at least 6.5m, although they remain partly buried. The north furnace is in a very complete state, but the south furnace has suffered partial collapse. It appears that the ground levels were raised by up to three metres during the later twentieth century; consequently the remains of associated features are also likely to survive.

Fragility/vulnerability: **MEDIUM**. The Stirchley furnaces are within the Telford Town Park, and so the site is not available for commercial development. Landscaping works for improved access and interpretation may adversely impact on the site. Parts of the structure will need consolidation to prevent further collapse.

Diversity: **VERY HIGH**. The Stirchley furnaces themselves have a modest diversity value – in that they were used for a sole and very specific purpose. However, considered in the light of the immediate and wider context of the various diverse industrial processes which took place in the Stirchley complex (and the wider Botfield enterprise), the site does possess a range of varied and distinct structural and spatial components required for iron production, the value of which is enhanced by the mutual survival and known relationships. The development of hot blast and the refinery also demonstrate an increased diversity in both technology and the use and arrangement of industrial spaces during the continuing Industrial Revolution of the first half of the nineteenth century.

Potential: **VERY HIGH**. The Stirchley furnaces and their associated complex appears to survive in a very good state of below-ground preservation. Other Botfield furnaces (such as at Old Park) have been destroyed completely with limited archaeological involvement. Moreover many nineteenth century furnaces have been investigated without taking into account their environs: at Stirchley the whole smelting complex appears to survive largely intact. There appears to be good potential for the survival of archaeometallurgical remains associated with the early development of the hot blast process, the refinery, and with other aspects of the metallurgical process.

Overall, the Stirchley furnaces site is of high local and regional significance, and of considerable archaeometallurgical interest. It represents a rare archaeological survival of a complete hot blast complex of the early nineteenth century. If the tentative association with the Botfield patent can be confirmed, then the site will be of national significance.

8. RECOMMENDATIONS

Archaeological work at the Stirchley furnaces site has revealed that the remains of the early nineteenth century Botfield concern survive in a good state of preservation – both above and below ground. However further work would refine understanding, and enable clearer characterisation, of the history, development, operation and survival of the site.

8.1 Further investigation and research

Further investigation and research would include both fieldwork and historical research. The site itself shows considerable potential for the recovery of archaeological information – including both improved understanding of the layout and arrangement of the site, and metallurgical samples which may shed light on aspects of the site's operation. Potential areas of further investigation include:

- Excavation to confirm the suspected original ground level;
- Excavation around the furnaces at the original ground level to reveal the layout of the casting houses and associated features;
- Excavation of the four hot blast stoves known to exist in 1856, and likely to survive – at least in part – below the present ground surface;
- Excavation and recording of the flues and pipes running between the blast furnaces and the hot blast stoves;
- Excavation of the putative second bank of furnaces to the east of the furnace structure described in this report, with a similar potential for the recovery of archaeological and metallurgical data;
- Recovery of archaeometallurgical samples from secure contexts relating to the use of hot blast;
- Excavation of the 'refinery' associated with the blast furnace site, including air furnaces, casting floors and other features;
- Recovery of archaeometallurgical samples from secure contexts relating to the operation of the refinery;
- Excavation of the engine house, blowing house and regulator;
- Landscape survey and excavation of communications routes within the ironworks;
- Excavation of the storage facilities along the eastern side of the site;
- Investigation and possible excavation of the water reservoirs and other features at the northern end of the site.

In addition to these archaeological aims, further research in the John Rylands Library would greatly enhance understanding and interpretation of the site.

There has already been a very successful engagement of local volunteers and community groups with aspects of the Town Park project. As noted above, the excavation and recording at Stirchley was greatly assisted with the involvement of local communities. Future archaeological investigation and research should continue to develop as a community project – with local civic societies, educational establishments, charities and individual members of the public fully embedded into the process.

8.2 Publication

The significance of the site is such that formal academic publication of the results of archaeological investigations is strongly recommended. With some additional research, and further work in preparing text and illustrations, a paper should be published on the preliminary results of the work undertaken so far. It is recommended that the national peer-reviewed journal *Historical Metallurgy*, produced by the Historical Metallurgy Society, would be the most appropriate location.

In due course, after the completion of remediation works, and with further investigation and research as recommended in 8.1 above, a follow-up paper should also be produced. Alternatively, if it is eventually possible to undertake archaeological investigation of the whole site – including the hot blast stoves, engine houses and refinery – then there may be sufficient material to produce a monograph. Again, the Historical Metallurgy Society (which has a long-established series of 'Occasional Publications') may be the most appropriate organisation to help deliver this. There are a range of alternatives, including the Royal Archaeological Institute and the Society of Antiquaries of London, both of which may also award grants toward publication in their own series of reports.

8.3 Management and conservation

The short-term management of the site is best served by avoiding any further groundworks or other disturbance. If such work is unavoidable, then archaeological monitoring should accompany any groundworks. This will enable further characterisation of the nature, extent and state of preservation of any archaeological remains.

In the medium term, consideration should be given to the preparation of a Conservation Management Plan (CMP) which would enable future work to take place within a framework of understanding. The CMP should identify areas of archaeological potential, conservation issues and areas for further research. It should place the Stirchley furnaces site in its local, regional and national context. The results of archaeological excavation and monitoring should inform the CMP, and reference should also be made to appropriate regional and national research frameworks. These should include:

- West Midlands Regional Archaeological Research Framework (English Heritage / University of Birmingham);
- 'Metals and Metalworking: a research framework for archaeometallurgy' (Historical Metallurgy Society / English Heritage);

- Science for Extractive Industries (English Heritage).

8.4 Interpretation and understanding

The Stirchley furnaces site is well-placed to provide a unique interpretation of early nineteenth century hot-blast ironmaking and its associated trades. Conservation of the site should ensure that elements of the historic environment which relate to that story should be highlighted and interpreted. Where appropriate, such interpretation should include reference to the wider 'Botfield landscape', including the Hinkshay forge site and the rows of workers' housing at Hinkshay. Links should also be made to the wider extractive and metalworking landscapes of the East Shropshire Coalfield (including the Ironbridge Gorge World Heritage Site). In addition, the later use of the site for the Wrekin Chemical Works should also be interpreted.

Fig. 34. Signatures of all three Botfield brothers against the Stirchley accounts for 1828-1829. From documents in the John Rylands Library at the University of Manchester.

REFERENCES

PRIMARY SOURCES

Patent 5596: *Manufacture of Iron*, Thomas Botfield, 2nd January 1828.

Ironbridge Gorge Museum Trust
IGMT 1973.281: Near Shiffnal [sic], lithograph by Francis Nicholson, 1820.

Northamptonshire Record Office
NRO Th. 3182. Journal of a journey undertaken by John Thornton, August-September 1819.

Shropshire Archives
SA 512/2/3/1/55. Lease 31 August 1813.
SURRENDER OF LEASE **513/2/9/5/6** *30 Aug 1813*

John Rylands Library, University of Manchester
BOT 2/31/2 Cash Account Book: Stirchley Furnaces 1822-1828
BOT 4/4 Valuation of Old Park and Stirchley Ironworks 1856

SECONDARY SOURCES

Access to Archives 2011, *Administrative history of the Botfield collection*, at http://www.nationalarchives.gov.uk/a2a/records.aspx?cat=133-bot&cid=0#0 [accessed 18th May 2011].

Armand Dufrénoy, Léonce Elie de Beaumont, Auguste Perdonnet and Léon Coste 1837, *Voyage Metallurgique en Angleterre*, 2 vols (second edition), Paris: Bachelier.

Clarke, N. J., n.d., *Gilbert Gilpin 1766-1827: agent, trade correspondent and chain maker*, Broseley Local History Society website, at http://www.oldcopper.org.uk/Broseley/gilbert_gilpin.htm [accessed 28th April 2011].

Corrins, R. D. 1970, 'The Great Hot Blast Affair', *Industrial Archaeology* 7, 233-263.

Eggert G. C. 1994, *The iron industry in Pennsylvania*, Pennsylvania History Studies 25, Middletown: The Pennsylvania Historical Association.

English Heritage 2002, *With Alidade and Tape: graphical and plane table survey of archaeological earthworks*, Swindon.

English Heritage 2006, *Understanding Historic Buildings: a guide to good recording practice*, Swindon.

Harris and Pearson n.d., *Company History*, on the Harris and Pearson website , at http://www.harrisandpearson.info/hphistory.htm [accessed 29th April 2011].

Institute for Archaeologists 2008, *Standard and Guidance for excavation*.

Institute for Archaeologists 2008, *Standard and Guidance for the archaeological investigation and recording of standing buildings or structures*.

Luter, P. A. 2004, *The ancient brook systems of the north-east Shropshire coalfield*, privately published.

Luter, P. A. 2005, *The history of ironmaking in Dawley*, privately published.

Morton, G. R. and Wingrove, J. 1969, 'Slag, cinder and bear', *Bulletin of the Historical Metallurgy Group* 3, 55–61.

Mushet, D. 1840, *Papers on Iron and Steel, Practical and Experimental etc*., London: John Weale.

Page-Smith, K. 2010, *Telford Town Park, Parks for People Project: Archaeological and Historical Desk-Based Assessment*, Nexus Heritage, Report No.3035 (unpublished report for Telford and Wrekin Council).

Percy, J. 1864, *Metallurgy: Iron and Steel*, London: John Murray.

Riden, P. and Owen, J. G. 1995, *British Blast Furnace Statistics 1790-1980*, Chesterfield: Merton Priory Press.

Smiles, S. 1863, *Industrial Biography: Iron Workers and Tool Makers*, London: John Murray.

Trinder, B. 1977, *The Most Extraordinary District in the World: Ironbridge and Coalbrookdale*, Chichester: Philimore.

Trinder, B. 2000, *The Industrial Revolution in Shropshire*, Chichester: Philimore (third edition).

Ure, A. 1843, *A Dictionary of Arts, Manufactures and Mines*, London (third edition).

Ward, T. H. 1885, *Men of the Reign. A biographical dictionary of eminent persons etc*., London: Routledge.

APPENDIX 1: LIST OF CONTEXTS

List of excavated contexts associated with the southern furnace.

No.	*Type*	*Description/interpretation*	*Relationships*
1000	Layer	Mixed rubble (sandstone, brick and firebrick). Topsoil.	Above 1015
1001	Structure	Circular vitrified firebrick shaft. Southern furnace stack lining.	Filled by 1028
1002	Structure	Ashlar stone wall oriented east-west. North wall of eastern arch.	Abuts 1001
1003	Structure	Truncated brick arch. Former arched roof of eastern arch.	Above 1002
1004	Structure	Firebrick and concrete infill of former flue in north-eastern pier	After 1002
1005	Structure	Brick floor within eastern arch	After 1005
1006	Structure	Ashlar and rubble foundation. South-eastern pier.	Before 1008
1007	Structure	Flue within 1006, curvilinear.	Filled by 1032
1008	Structure	Brick foundation to south of 1006. South-eastern pier extension.	After 1006
1009	Structure	Brick wall abutting `1006, oriented north-south. Later addition.	Same as 1011
1010	Structure	Dry stone wall oriented north-south, east end of east arch.	Above 1005
1011	Structure	Brick wall abutting 1015, oriented north-south. Later addition.	Same as 1009
1012	Structure	Brick wall blocking north end of south arch. Later addition	Same as 1011
1013	Structure	Sandstone block set within 1014.	Same as 1014
1014	Structure	Brick foundation to south of 1015. South-western pier extension.	Abuts 1015
1015	Structure	Ashlar and rubble foundation. South-western pier.	Before 1001
1016	Structure	Brick floor surface on western side of south arch, abutting 1011.	Above 1024
1017	Structure	Brick floor surface on eastern side of south arch, abutting 1009.	Above 1024
1018	Structure	Circular wrought iron barrel adjacent to south end of 1011.	Cuts 1024
1019	Structure	Vertical cast iron pipe within 1018.	Before 1020
1020	Fill	Dark grey-black tar-rich silty clay.	Fill of 1018
1021	Structure	Cast iron pipe to north-west of 1018	Within 1023
1022	Layer	Mixed sandstone rubble deposit south of southern arch	Above 1024
1023	Layer	Grey-black loose cindery fill within southern arch	Below 1016
1024	Layer	Dark grey silty clay	Below 1023
1025	Structure	Brick wall at west end of eastern arch. Later addition.	Abuts 1002
1026	Structure	Sub-rectangular opening in east wall of 1001. Casting arch.	Same as 1001

No.	*Type*	*Description/interpretation*	*Relationships*
1027	Layer	Iron-rich deposit within 1001. Furnace 'bear'.	Below 1028
1028	Layer	Mixed rubble and silt fill of 1001. Demolition and collapse.	Below 1000
1029	Structure	Truncated former opening in south wall of 1001. Blowing arch.	Same as 1001
1030	Structure	Sub-rectangular opening in west wall of 1001. Blowing arch.	Same as 1001
1031	Layer	Patches of tar on 1016 and 1017	After 1016
1032	Structure	Firebrick and concrete infill of flue 1007.	After 1007
1033	Structure	Brick wall at southern end of southern arch, oriented east-west.	Above 1024
1034	Structure	Partly collapsed opening in north wall of 1001. Blowing arch.	Same as 1001

APPENDIX 2: DRAWINGS