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Downside Mill, Cobham: an evaluation with notes on observations at Coxes Lock Mill, Addlestone

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with a contribution by
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Between 30 July and 12 August 2008 a team from Surrey Archaeological Society undertook a training excavation in the form of an evaluation, on the site of one of the former iron- and copper-working mills at Downside, Cobham, operated by Alexander Raby between 1770 and 1806. Two trenches were opened to investigate the nature and survival of the mill structure, search for evidence of possible medieval utilisation of the site, and ascertain the precise location of the large dwelling house (set in pleasure grounds) shown on a plan of c *1798. The search for the house was unsuccessful and no evidence was recovered for medieval activity on the site. However, the work revealed remains of substantial exterior walls of the targeted former mill with some internal features, together with the filled-in courses of the former millraces that channelled water to the waterwheels. Significant concentrations of demolition material were recovered, particularly from one of the filled-in millraces, including large quantities of metallurgical industrial residues. Specialist analysis of the large pieces of slag in the demolition material from Downside Mill and of rectangular slag blocks from Coxes Lock has suggested these came from reverberatory furnaces used for reheating iron and recycling scrap iron for the manufacture of iron hoops, iron bar, iron plate and tinned iron plate. The slag masses lining the tail-race and river at Downside Mill were from chafery hearths. Documentary sources suggest that the copper foundry may have been used for the manufacture and recycling of copper sheet for sheathing naval ships. The site archive will be deposited at Elmbridge Museum under accession no 1.2017.*

Background

The Downside Mill complex of buildings lies *c* 2.6km to the south-east of Cobham, at TQ 117 583 (fig 1). Over recent years David Taylor has carried out a considerable amount of detailed historical research in the Cobham area. This has provided much background to the origins and development of the site, significantly advancing our understanding since its barely cursory mention in a 1921 survey of Surrey mills, which suggested that little was known.[1] The following outline of the known history of the site has been taken from *Alexander Raby: Ironmaster*.[2] The Domesday Survey records there were three mills in Cobham Manor. Although the precise locations of these are not known, Taylor has suggested one of them was at Downside. There is a 1331 reference to a corn mill at Downe. However, by 1565 the mill at Downe was in disrepair as an agreement was entered into to renovate the decayed structure. It appears that during the 17th century a paper mill was introduced alongside the existing corn mill; the last reference to the milling of corn at Downe is in 1720. The mill house and paper mill at Downe Mills burnt down in 1733 and were promptly rebuilt; the mill continued for paper-making until 1770, when the mill and remainder of the site was leased by Alexander Raby, initially for the processing of iron.[3] The first documentary evidence for a copper foundry at Downside is the 1798 plan, but further research has now revealed (see Annex B) that the large copper foundry at Downside Mill, which does not seem to have parallels at other 18th century ironworking sites on the rivers Mole and Wey, may have been constructed to fulfil Alexander Raby's contracts with the Navy Board for the copper-sheathing of the hulls of naval ships in the 1780s.

1 Gardener 1921, 116.
2 Crocker, G (ed) 2000, particularly from Potter, 9–14, Taylor, 15–21 and Crocker, A, 22–8.
3 Raby acquired the freehold between 1781 and 1783.

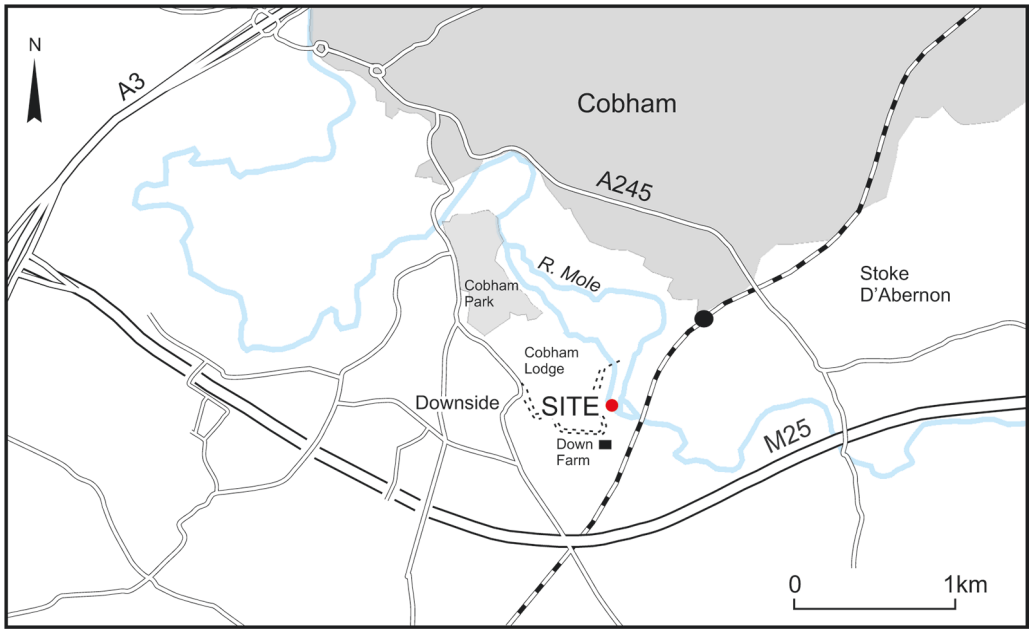

Fig 1 Downside Mill, Cobham. Site location plan. (© Crown copyright 2017. OS 100014198)

It is apparent that Raby needed to remodel the Downside Mill site, as the existing paper-milling premises would have been unlikely to meet the needs of the iron forging industry and late in 1770 he purchased over 52,000 bricks, 12,000 plain tiles and 100 ridge tiles for the site. It remains an open question as to whether these were used to rebuild all or part of the paper mill he had just acquired or to construct other buildings, including possibly the substantial dwelling house.

It is assumed that the paper mill acquired by Raby in 1770 was the oval-shaped building marked 'Mill' on the 'Plan of Cobham Mills Belonging to Alex. Raby Esq' (fig 2, *c* 1798, hereafter the '1798 plan').[4] This mill has a very different morphology to the mill buildings that Raby later constructed on the remainder of the site; it has external waterwheels (one in the wider northern millrace and one in the narrower southern millrace) whereas the later buildings are strictly rectangular with internally placed wheels and underground tail-races. The shape of the oval-shaped mill appears medieval or very early modern in date, rather than that of an industrial mill constructed in the 18th or 19th centuries. A consideration of the existing waterways in the vicinity of Down Farm and Downside Mills indicates that a number of changes to the course of the river Mole and to the location of mill-head ponds at Downside have been made since medieval times, including major changes by Alexander Raby at the end of the 18th and the beginning of the 19th centuries.[5] By 1809, following embankment of the upstream river in 1787/88,[6] the head of water at Downside Mill was said to amount to 11 feet (3.36m).[7] The presumed paper mill acquired by Raby in 1770 stands on an embankment higher than the level of the streams draining Down Farm and its medieval moat, which pass through the embankment in a culvert draining into the tail-race; it is thus likely to be later than any medieval mill in the vicinity, although whether the mill-head embankment dates to the rebuilds of 1565 or 1733 is not known. A later rather than an earlier date seems likely, but one probably preceding Raby's acquisition in 1770. The mill-

4 See Crocker (ed) 2000, 26 for a discussion on the dating of this plan (SHC: 2610/38/21).
5 Crocker, A, 2000; Taylor 2000.
6 Crocker, A, 2000, 26.
7 Taylor 2000, 20.

head embankment may have been further heightened during Raby's embankment of the upstream river in 1787/88. All the watercourses in the vicinity of Raby's works, including several hundred metres of the embankments of the Mole lying upstream of the mill complex, are roughly lined with substantial quantities of lumps of slag.[8]

By 1781 the Downside Mill site contained one iron mill, two forges, two 'shops' (ie workshops) and a messuage – at this early date there is no mention of a copper foundry. By the turn of the century Raby had constructed alongside the acquired mill a substantial complex consisting of a number of attached new rectangular brick-built works containing at least three major waterwheels. The 1798 plan shows that by then the complex was of a considerable size, including the old and new mill buildings (the latter which survive today as offices) incorporating an iron foundry, a copper foundry, a forge, a tilt-hammer and various workshops (including the 'Women's Shop') together with a separate smithy and a substantial dwelling house with 'Pleasure Grounds' and assorted ancillary accommodation. No structures on the site today pre-date the remodelling undertaken over the period from 1770 to 1798.

Raby's manufacturing operations on the site continued into the early 19th century, and in 1804–5 a series of workers' cottages[9] were constructed overlooking Downside Common, presumably for occupation by workers at the mill complex. In 1806 Raby sold the mill complex to a Mr John Bunn. By 1809 the mill site was for sale again and is recorded in 1810 as belonging to Jackson & Co. The iron mills had been dismantled by 1814[10] and the mill buildings were used from 1818 as a flock mill – turning rags from old clothing and furnishings into 'flock' for the stuffing of mattresses. The large dwelling house had been removed by 1839, as shown in figure 3, and by 1871 the surviving parts of the complex were being used as a sawmill. Industrial working at the site decreased as the 19th century closed, with the site being variously used for pumping water and generating electricity before being converted to office and residential uses, as it remains today (fig 4).

The site of the earlier oval-shaped mill, demolished before 1839,[11] is shown in 1866 as an ornamental garden with many flowerbeds reminiscent of a 'Paisley' pattern adjoining the open mill-head pond.[12] By 1885 this ornamental garden had been abandoned and replaced by a woodland area; the adjacent part of the mill-head pond was silting up and had become marshy.[13] By 1896 this western portion of the mill-head pond adjacent to the former oval-shaped mill had been completely filled in.[14] The changes at the site between 1798 and 1839 are shown in figure 3.[15]

Previous archaeological work and desktop assessment

The desktop assessment consisted primarily of the study of the 'Alexander Raby, Ironmaster' conference proceedings[16] supplemented by further maps and plans made available by Dr David Taylor and the report of trial trenching at the adjacent Down Farm.[17] Archaeological investigation of the site had been limited to a resistivity survey, carried out by David and Audrey Graham in 2007[18] of the prospective area of the training excavation. Geophysical survey has, at best, a patchy success rate in Surrey, but on this occasion the resistivity survey proved successful, providing strong signals in the area of the expected oval-shaped mill

8 An example is shown in fig 10 of Annex A.
9 Originally Tin Row, later Tinmans Row, which still survive.
10 SHC: 1865/3/1, 171.
11 Probably in 1814.
12 COBPK/5/3: plan attached to a conveyance dated 25 May 1866.
13 25-inch OS map surveyed 1867–9 and printed 1885.
14 OS 25-inch 2nd edn map 1896, surveyed 1867–9, revised 1894.
15 Based on the '1798 plan' and a 'Map of Cobham Parish surveyed for the Poor Law assessment', 1839: SHC 2558/1.
16 Crocker G (ed), 2000.
17 Graham *et al* 2005.
18 Howe *et al* 2010, 305.

Fig 2 Downside Mill, Cobham. Plan of Cobham [Downside] Mills belonging to Alexander Raby *c* 1798, from the Buttriss Archive (SyAS Research Collections). The plan is oriented with south to the top.


Mill Garden
Road to Down Farm
Mill
Pleasure Ground
Dwelling House
Bridge
Coach Room
Gibbs House
Kitchen Garden
Marsh Meadow
Road to Cobham

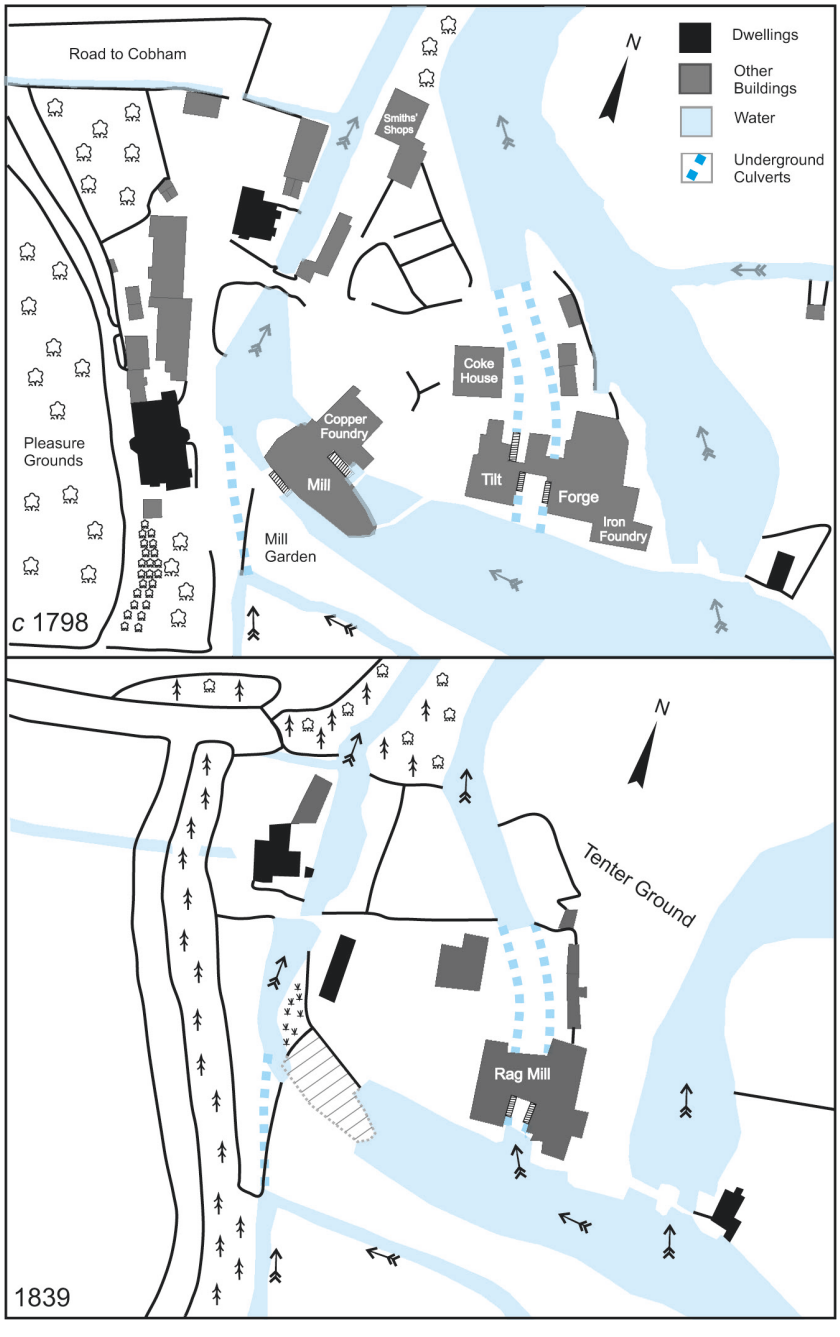

Fig 3 Downside Mill, Cobham. Two plans (based respectively on the 1798 plan in figure 2 and the Cobham Poor Law Assessment map of 1839, SHC 2558/1) illustrating the changes to the site that took place between 1798 when the iron and copper mills were in use by Raby and 1839 when the remaining mill was used to produce flock. By 1839 the site of the mill adjacent to the copper foundry in 1798 remains as a relict feature with the tail-races from it to the west now draining only the moat and surrounding fields of Downside Farm through a culvert in the embankment; the tail-race and the western end of the mill-head pond were beginning to silt up. The large dwelling house to the west of the mill site has been demolished and the lane running south to Downside Farm has been relocated away from the tail-race towards the west. The river Mole now runs to the north through the 'New Cut' created by Raby.

Fig 4 Downside Mill, Cobham. The obsolete water wheels on the south side of the later 18th century phase of Alexander Raby's iron mill at Downside. (Photograph by Andrew Norris, 2008)

structure and the surrounding former millraces. It became clear during the excavation that the extreme conductivity of the southern millrace shown in the resistivity survey was due to a concentration of ironworking debris deposited in it during the dismantling of the iron mills.[19]

The import of the plan of 1839, showing the 'fossilised' eastern and western ends of the oval-shaped mill was not fully recognised until halfway through the excavation.

The excavation

The principal aim of the evaluation was to investigate the state of survival of the archaeological deposits while gathering evidence relating to aspects of Raby's period of occupation and industrial activities at the site. The evaluation focused on the presumed oval-shaped mill and its two millraces. It was hoped that the evaluation might provide some insights and dating evidence regarding the extensive water-management arrangements around the mill, including the construction of the oval-shaped mill and its watercourses, and for the suggested earlier medieval and early post-medieval mill workings, about which very little is known beyond the rather sketchy documentary references. It was also hoped to ascertain the precise location of Alexander Raby's dwelling house at the site, which is depicted on the 1798 plan as lying close to the western end of the mill, but of which no visible traces now survive. Two

[19] Probably in 1814 (SHC: 1865/3/1, 171).

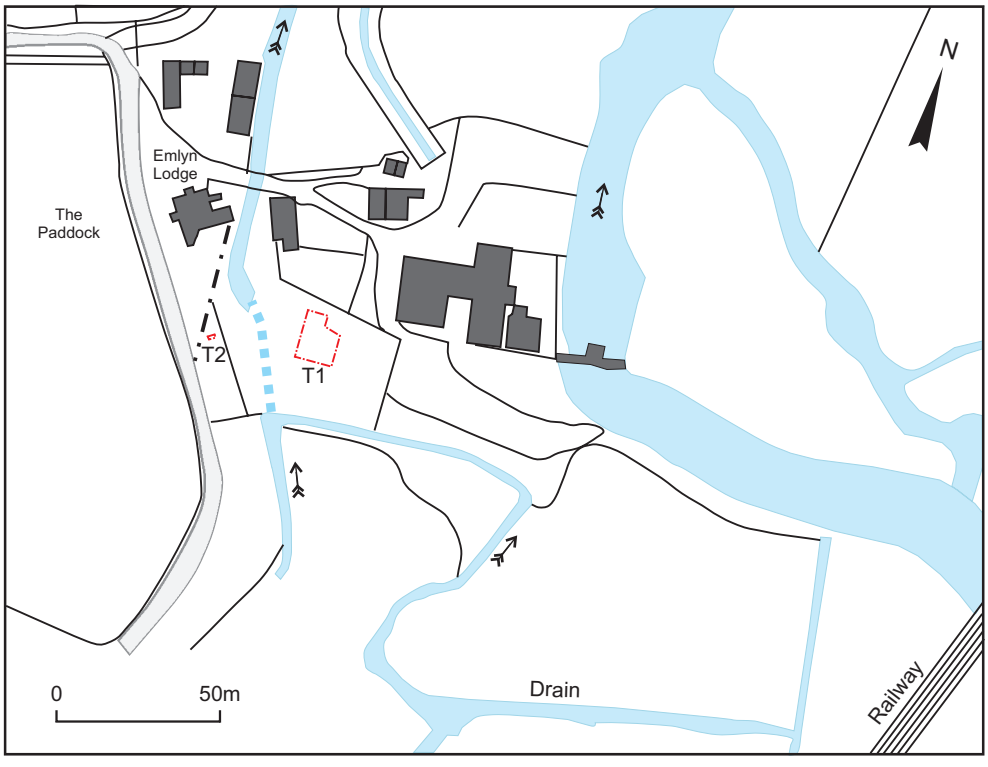

Fig 5 Downside Mill, Cobham. Plan showing the location of the two trenches at Downside Mill and Emlyn Lodge (with its paddock to the west across the road). (© Crown copyright 2017. OS 100014198)

trenches were opened in order to accomplish these aims (fig 5). The detailed stratigraphic report, with summary notes on the artefacts recovered, is available online.[20]

Summary of the two trenches

Trench 1 measured 15 x 11.8m and was positioned over the area where the resistivity survey had indicated the main body of the remains of the oval-shaped mill were sited, being large enough to investigate not only the central mill structure but also the millraces to the north and south of the 'island' on which the structure was located. The excavation exposed the top of the remaining walls of the demolished oval-shaped mill (the higher levels having been removed at the time of demolition of the mill) and the highest surviving working surface within the mill. Excavation proceeded deeper into the presumed northern wheel pit, the wider northern millrace approaching the wheel pit and the narrower southern millrace.

It quickly became apparent that the wider northern millrace had been closed to the passage of water by insertion of a curved-faced double-thickness brick crossing structure, interpreted as a dam constructed at the time that the mill went out of use around 1814 (figs 6 & 7). The wheel pit lay immediately to the west of this structure and was filled with demolition deposits. To the east of the dam was a sequence of deposits, some interpreted as soil and clays deliberately dumped into the stagnant mill pond in the later 19th century and others as representing silting of the increasingly shallow end of the millpond, until it was completely filled in by the end of the 19th century.

[20] See *Endnote*.

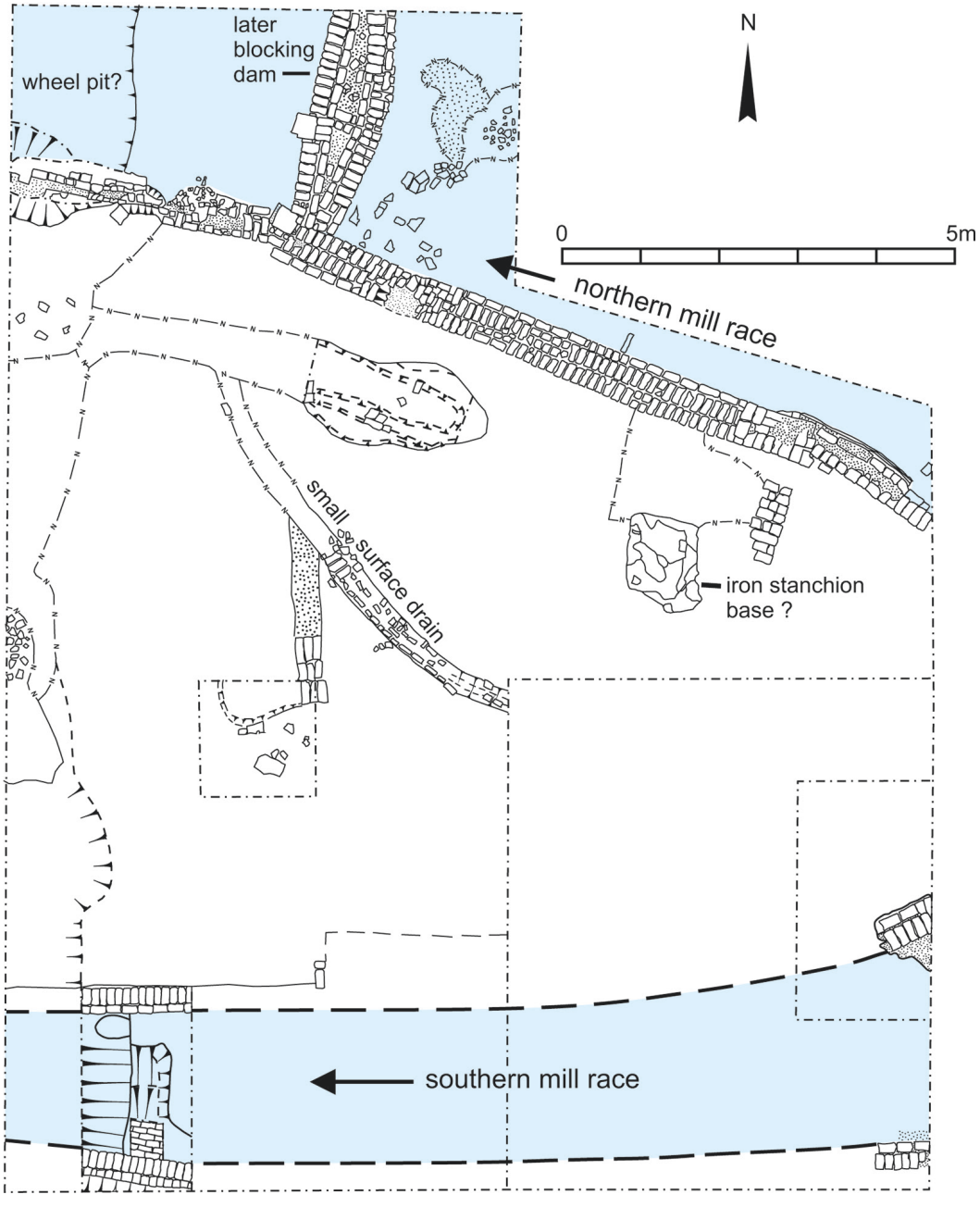

Fig 6 Downside Mill, Cobham. Plan of excavated features in trench 1. The blue tint shows the mill-head races before they were filled in after demolition of the mill.

The narrower southern millrace was of a very different character, with brick walls and floor apparently built as a unified structure (fig 6; fig 15 – see *Endnote*, stratigraphic report). A sondage across the southern millrace showed it to narrow considerably from east to west, from a width of 1.95m to a width of 1.70m over the 1.4m length of the sondage. This narrowing must have accelerated any flow of water so that by the time the flow reached the wheel

Fig 7 Downside Mill, Cobham. The brick structure, in the northern millrace in trench 1, constructed as a dam to block the flow of water at the time of demolition of the mill. The mill-head pond lay to the left (east) of the structure. (Photograph by Richard Savage, 2008)

(presumed to be to the west of this point) it would have been travelling with considerable force and speed. The fill of this southern millrace included water-laid clays (containing remains of leather straps and a shoe) and considerable quantities of metallurgical waste, including broken-up furnace floors and waste products. The 1839 map suggests that any formal 'dam' to this southern channel lay to the east of the sondage cut across it. Presumably both millraces were dammed at the same time (with water from the mill-head pond then exiting through the millraces of the later rectangular iron mills lying to the east of the oval-shaped mill).

Trench 2 was designed to be a much simpler evaluation to confirm the position of the substantial dwelling house of Raby's time and was on a significantly smaller scale (measuring only 2.5 x 1m). The very slight deposits found have been characterised as more probably a garden path than the remains of any structural foundation of a large dwelling house. It is known that after Raby's time the road from Downside Mill to 'Down Farm' was relocated from the east of Raby's dwelling to the west (as shown in fig 3) and it is possible that groundworks during this period removed all traces of the foundations of Raby's house. Two resistivity surveys carried out in the garden of Emlyn Lodge[21] during the training excavation revealed no clue as to the location of Raby's dwelling house.

Given the limitations of a training excavation and the unexpected quantity of metallurgical finds, the evaluation excavations failed to answer a number of the original research aims. The period of Raby's occupation of the site was clearly apparent through the remains of the mill, millraces and metallurgical deposits. At few points did the investigations approach archaeological deposits that could have revealed insights into either the original construction of the mill site (only the remains of the walls at the time of the final demolition were revealed) or examine deposits below these that would have provided the information regarding the formation process of either the oval-shaped mill or the millraces that defined it. However, it can be confidently suggested that were further investigations to take place on the site such evidence would be likely to be forthcoming, as the preservation of the remains overall was found to be remarkably good. Further work is needed to understand the sequencing and dating of the northern and southern millraces – and in particular changes introduced to the structure by Raby after his acquisition of the mill in 1770. The 1798 plan suggests that the northern millrace had been originally designed for a wide wheel, even if by the time of the plan the original wide wheel had been removed and replaced by a narrower wheel in a modified millrace. The southern millrace was found to be of a different design, with facing brick walls and base being constructed in a single phase of works, possibly as a replacement for an earlier millrace in that position.[22]

The investigations also failed to reveal any trace of medieval activity. With the excavations being fairly limited this is perhaps unsurprising, and it is certainly the case that Raby's large-scale works at the site could have removed all traces of prior activity. The lack of any residual medieval material from the site or in the surrounding area (apart from at least a dozen possibly medieval stone blocks seen incorporated in a later structure at the downstream end of one of the underground tail-races of the rectangular mills) does not support the conjecture that the earlier medieval mill(s) were located here. It has become clear that any levels associated with a medieval mill site at this location would now be buried deep beneath the extensive works to raise the height of the river on the upstream side of the late 18th/19th century iron mills. As noted above, the outflow from the 'moat' at the medieval Down Farm passes in a conduit well below the surface level of the embankment on which the oval-shaped mill was constructed. The documented medieval mill site at Downe might have been located closer to Down Farm or elsewhere in the general vicinity.

[21] Constructed *c* 1880 on the site of the former 'dung yard' and former road to 'Down Farm' shown in the 1798 plan.

[22] It was not possible to investigate this further during the excavation.

Remains of iron and copper industrial processes

The discovery of so much material from the dismantling and demolition of the iron and copper works, principally as infill in the southern millrace, had not been anticipated and no specific sampling strategy was in place. During the autumn of 2008 a MAP2-style assessment of the 55kg of initially retained material was commissioned from Dr David Starley.[23] Dr Starley recommended further analysis as the material was in his view of potential national significance in understanding more about important technological changes in the iron industry in the last quarter of the 18th century. This preliminary conclusion was confirmed by Dr David Cranstone.[24] As a result Dr Barney Sloane of English Heritage agreed that the archaeometallic samples should be analysed by Dr David Dungworth and Dr Sarah Paynter (later joined by Matt Phelps, a research student) at the English Heritage laboratories at Fort Cumberland, Portsmouth. As the material was compared with that from other sites this phase of the work ran from 2009 through to November 2013, during the course of which views on the technological processes involved were revised.

During this extended period of analysis two examples of dense slag lumps were recovered from the extensive amounts of such material lining Raby's artificial watercourses and the upstream embanked reaches of the Mole (one from a now disused tail-race and the other from the embanked river). These were included in the English Heritage analysis and are discussed with the material from the mill site in Annex A.

The final report (Paynter *et al* 2017) is included as Annex A to this article. Their report concludes that the Downside and Coxes Lock sites 'provide a rare snapshot of late 18th century Surrey ironworks and the adoption of the reverberatory furnace in this important but poorly understood transitional period'.

The report by Starley[25] gives additional details of artefacts related to the processing of copper, including a 'skull' of copper processing residues from a ladle and 'rails' for the casting of copper objects.

Other work at Downside Mill

One of the Society's volunteers, Roman Golicz, made a measured survey of two short tunnels covering respectively the northern and southern tail-races to the west of the oval-shaped mill. These post-date the 1798 plan and were blocked when the mill was demolished *c* 1814. The results of the survey are included in the site archive.

Metal-detecting surveys within the area of the evaluation trenches were not possible owing to the very large amount of metallurgical waste and iron artefacts from the demolition of the mill building across the whole of this area. Metal detecting was carried out across The Paddock to the west of Emlyn Lodge, in an area formerly part of the 'Pleasure Grounds' of the large dwelling house present in the second half of the 18th century and which was still standing in 1809.[26] Most of the finds were from the 20th century; a summary is included in the electronic publication of the Stratigraphic and Artefacts reports (see *Endnote*) with full details in the site archive. Most of the finds were returned to the landowner, Mr Dominic Combe, or members of the Combe family, or reburied on the site at his request. The only significant artefact for the purposes of the present report is a lead cloth seal from the Greenwich Naval Hospital, at the time only the second of this type of seal to have been discovered in Cobham.[27] It may well have sealed a bag of old clothing/cloths sent to be re-processed at the flock mill in the years after 1818.

[23] A copy of his report containing a listing of the material is available online (see *Endnote*).
[24] Consultant's opinion – see *Endnote*.
[25] See *Endnote*.
[26] Taylor 2000, 20, which refers to a notice in *The Times*, 8 May 1809.
[27] For a description of this type of seal see Egan 1999, 192–5.

Coxes Lock, Addlestone

During the course of work by the National Trust on the Wey Navigation at Coxes Lock in November 2009 the canal immediately upstream from Coxes Lock was drained, revealing a wall constructed from timber, brick and cast slag blocks, previously seen in 1990,[28] regulating the connection between the Navigation and the 7¾ acre mill pond, created by Alexander Raby *c* 1782. In 1990 the rectilinear slag blocks in this complex structure were recorded as measuring 20 x 9 x 5 inches.[29] In 2009 the cast slag blocks were recorded as *c* 24 x *c* 9 x *c* 4½ inches (690 x 228 x 116mm).[30] The blocks had a dark greenish tint and were initially considered to be probably from the processing of copper, perhaps in connection with operations to make or refine copper or to separate copper from iron in reprocessing activities.[31] Subsequent to the uncovering of the sluice wall in 2009 a report and a schematic drawing were deposited in the Surrey Historic Environment Record.[32] In 1990 a slag block containing one end of a long iron strip or flattened hoop, *c* 0.46m long, 27mm wide x 2mm thick, encased within it had been discovered close to Coxes Lock and deposited with Chertsey Museum. Subsequent chemical analysis at the English Heritage laboratories of fragments of the blocks recovered in 2009 and the specimen discovered in 1990 showed these blocks of cast slag were derived from reverberatory furnaces processing iron rather than copper (see below, Paynter *et al*, Annex A).

The opportunity for a training excavation

Prior to 2008 Surrey Archaeological Society had not offered any formal training courses for beginners for some years and an evaluation of the potential of Downside Mill offered the opportunity to do so, on a site where the geophysical survey had recorded the presence of surviving structures close to the surface. Overall direction of the project was carried out by Richard and Pamela Savage with Tony Howe as the Director of Excavations. The evaluation excavation lasted for thirteen days, including a four-day course for eight students (on excavation and recording techniques), then a single day 'taster' for fifteen young people led by Abby Guinness and finally a second four-day course for a further eight students. The students ranged in age from 15 to 75 years. The four-day courses were led by Tony Howe. Fifteen experienced members of the Society were also present, carrying out a range of activities on the site, including site preparation and on-site finds processing.

ANNEX A

Metallurgical analysis and conclusions, by Sarah Paynter, Matt Phelps, David Cranstone and David Dungworth

BACKGROUND

By the end of the 18th century coke-fuelled furnaces were widespread.[33] The high-carbon pig iron made by the blast furnaces – coke pig – was excellent for casting but much of the demand was for carbon-free bar iron, which was tougher and could be forged (wrought) and welded. The challenge facing ironworkers was to find a way of converting cast iron from coke-fuelled blast furnaces (coke pig) into good-quality bar iron, preferably using coal or coke as the fuel, since charcoal was increasingly restricted.

[28] Barker 1990.
[29] *Ibid.*
[30] Barker 2011.
[31] *Ibid.*
[32] Surrey HER SSE5372.
[33] Tylecote 1986; Crossley 1990.

Various conversion processes, such as potting and stamping, were adopted for a period in the later 18th century,[34] but the method that came to dominate was dry puddling.[35] Henry Cort was a principal instigator in the development of puddling. Cort's patents of 1783 and 1784 were among a series by various ironworkers in the second half of the 18th century proposing methods for converting coke pig iron to malleable bar iron.[36] These nascent processes used reverberatory furnaces, which differed from conventional hearths, forges or furnaces in that the fuel was partitioned from the metal being heated. Instead hot gases from the burning fuel were used to heat the metal in a separate chamber of the furnace. The advantage of the reverberatory furnace was that coal could be used without the risk of contaminating the iron with deleterious sulphur because the fuel and metal were kept separate.

MATERIAL

Downside Mill

The waste from the excavation at Downside Mill included fragments of mould from the iron foundry and copper slag from the copper foundry, much of it being in the form of large masses of iron-rich black, dense slag, often with flow patterns on the upper surface (fig 8). Some of the slag was adhered to sandy refractory bricks that had formed the lining of a furnace (fig 9). The lining bricks were typically 50 x 100mm and grey or purple in colour although the outer layers were orange and oxidised fired.

Large masses of slag were also noted in the tail-race (fig 10) at Downside Mill. These masses had a fairly consistent shape and size of 6–9kg. They had a bowl-shaped base with large crystals visible in fracture surfaces; the top surface had a slight flow pattern and the edges were broken on all sides. These features indicate that the slag was poured hot from a furnace or hearth and allowed to cool slowly. Although the origins of these slag masses are uncertain, it is most likely that they were produced at Downside Mill during Raby's occupation of the site. Smaller fragments of the same type of slag were also found during the excavation.[37]

Fig 8 Top view of flowed slag from Downside Mill, Cobham.

[34] King 2012.
[35] Hyde 1983; Morton & Mutton 1967; Mott & Singer 1983.
[36] Hayman 2004; King 2012; Mott & Singer 1983.
[37] Phelps *et al* 2012.

Fig 9 Lower surface of flowed slag, with small quartz-rich bricks

Fig 10 Downside Mill, Cobham. Large slag mass from the tail-race lining.

Coxes Lock

At Coxes Lock, cast rectangular blocks of dark-coloured, dense slag had been used in the construction of the mill pond and its feed from the canal, thought to have been constructed around 1782, during Raby's ownership of the site (fig 11). The blocks were recorded in 1990 and again during drainage in November 2009 and are described by David Barker in the 2011 issue of the *Addlestone History Society Newsletter*. The sampled blocks are 0.12m high with flow lobes on the top surface and flattened folds on the sides but all were broken so the full width and length could not be gauged; the fragment in figure 11 weighed 2kg.

A similar fragmented block was discovered during previous building work at the mill and deposited with Chertsey Museum. This slag block contained one end of a long iron strip or flattened hoop, *c* 0.46m long, 27mm wide x 2mm thick, encased within it (fig 12). A sample

Fig 11 A cast block of slag from the mill pond at Coxes Lock, Addlestone

was also taken from this block for comparison with the others. These slag blocks are likely to derive from Coxes Mill, but the date is not known with certainty; Raby was no longer associated with the mill after 1807 although it continued to be used for metalworking until 1831.

RESULTS

The characteristics of ironworking slags can indicate the type of process taking place at a site. A selection of the waste from Downside Mill and samples of slag blocks from Coxes Lock were analysed at English Heritage.[38]

Chafery slag

The large slag masses from the tail-race at Downside Mill are likely to be from a chafery hearth – a coal-fuelled hearth used for reheating iron. The distinctive shape of the larger slag lumps is similar to the 'hambone', which Morton and Wingrove[39] describe as typical of chafery hearth slags. Small pieces of similar slag were found among the excavated material from Downside Mill although these were originally misinterpreted as foundry slag.[40]

Coal-fired chafery hearths were used for heating metal to make it more malleable and easier to shape. The slag from Downside Mill shows there was at least one chafery hearth in use there during the lifetime of the site. Some of this slag was adhered to iron oxide scale,

Fig 12 Cast slag block with iron strip from Coxes Lock, Addlestone. (Photograph by kind permission of Chertsey Museum, ref CHYMS-3237)

[38] For details of the methods used see Phelps *et al* 2012.
[39] Morton & Wingrove 1970.
[40] Phelps *et al* 2012.

Table 1 Composition of chafery slag from Downside Mill (TRL is the slag mass removed from the tail-race lining, the remaining samples were recovered in the excavation).

Sample	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	FeO
TRL	0.32	0.63	5.74	26.16	1.23	4.30	0.64	2.00	0.18	0.36	58.43
DM10	0.31	0.64	11.85	32.94	1.28	3.09	1.19	3.46	0.51	0.83	43.91
DM43-1	0.22	0.62	9.74	25.50	0.94	2.89	0.58	2.16	0.46	0.39	56.49

known as mill-scale, dislodged during hot working, and also to copper slag from the copper foundry. It is therefore likely that a chafery hearth was used for heating iron at Downside in the mill complex with the copper foundry.

Reverberatory slag

The flowed slag from Downside Mill, including the material adhered to the quartz-rich bricks, and the cast slag blocks from Coxes Lock, including the block with the embedded iron strip or hoop, all derive from reverberatory furnaces. These reverberatory furnaces were coal-fired and lined with quartz-rich bricks.

The reverberatory slag from Downside and Coxes Lock contained an oxidised form of iron called magnetite. This initially led to the conclusion that these furnaces were used for puddling since puddling, unusually for ironworking, requires an oxidising atmosphere. In most ironworking processes, an oxidising atmosphere is highly undesirable as it leads to the oxidation and loss of metal. The same conclusions have been drawn by other researchers about similar slag from other sites;[41] however, recent studies[42] suggest that the situation may be more complex. The atmosphere in coal-fired reverberatory furnaces was notoriously difficult to control and was often more oxidising than ideal. Perhaps a similar slag would be produced by most reverberatory furnaces, regardless of the process taking place.

So what were the reverberatory furnaces at Coxes Lock and Downside Mill used for? At this time, reverberatory furnaces were used for reheating iron and for recycling scrap iron as well as for conversion processes such as puddling. One of the main arguments against the furnaces being used for puddling is that the process had only just been developed and was initially problematic. The puddling process was patented for fourteen years by Henry Cort. Although Cort went bankrupt in 1789, the crown confiscated his patent rights, which only expired in 1798.[43] An ironworker in Cyfarthfa in Wales, named Crawshay, took a licence to use the puddling process at his works in 1787. However, the transition was not without problems, and puddling only became widespread from the beginning of the 19th century after Crawshay had introduced a prior refining stage, preceding the conversion proper

Table 2 Chemical composition of the slag from Coxes Lock (CL) and Downside Mill (DM) (copper and tin sought but not detected). Block 4 contains the iron strip or hoop.

Site	Sample	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	FeO
CL	Block 1	<0.1	<0.1	0.8	32.4	0.3	<0.3	0.2	0.2	<0.1	<0.1	65.9
CL	Block 2	0.1	<0.1	0.8	33.3	0.3	<0.3	0.2	0.1	<0.1	<0.1	64.8
CL	Block 3	0.2	<0.1	0.9	33.0	0.3	<0.3	0.2	0.2	<0.1	<0.1	65.0
CL	Block 4	<0.1	<0.1	0.8	32.0	0.3	0.3	0.2	0.1	<0.1	<0.1	66.2
DM	11	0.2	<0.1	1.4	27.1	0.7	1.0	0.4	0.4	<0.1	<0.1	68.7
DM	15	<0.1	<0.1	1.3	31.1	0.3	<0.3	0.3	0.1	<0.1	<0.1	66.2
DM	21	0.1	<0.1	2.5	29.9	<0.3	<0.3	0.3	0.5	0.1	<0.1	65.7
DM	37	0.2	<0.1	1.4	29.5	0.5	0.4	0.4	0.2	<0.1	<0.1	67.3

41 Killick & Gordon 1987; Gordon 1997.
42 Cranstone 2011; Proctor *et al* 2011.
43 Mott & Singer 1983.

(Young 2014); the slag from Crawshay's refining stage differs from the slag from Raby's mills. Subsequently, puddling forges tended to be located close to blast furnaces and sources of coal fuel.

One of Raby's main ventures was the supply of essential iron items such as barrel hoops, particularly for the Navy. During Raby's time at Downside Mill and Coxes Lock, in the second half of the 18th century, much bar iron was imported but recycling was also important.[44] Reverberatory furnaces were used for reheating and consolidating scrap iron, which once rolled made good-quality hoops, or simply for reheating iron between passes in rolling or hoop mills. Indeed many of the processes for converting coke pig to bar iron that were developed in the 18th century had origins in recycling practices.[45] The slag block containing what may be the remains of a barrel hoop adds further weight to the conclusion that Raby's reverberatory furnaces were used for reheating and recycling iron during hoop fabrication, rather than puddling as we now think of it. Therefore the Downside and Coxes Lock sites provide a rare snapshot of late 18th century Surrey ironworks, recycling and the adoption of the reverberatory furnace in this important but poorly understood transitional period.

ANNEX B

Alexander Raby and Downside Mill, by Pamela Savage and Richard Savage

Jeremy Hodgkinson has written regarding the mills on the rivers Wey and Mole in the 18th century and first quarter of the 19th century that 'The variety of ironwares produced at these sites was not consistent, and included hoops and wire, as well as domestic items such as pots and pans for which copper plating would be needed (which explains the presence of a copper foundry at Raby's Downside Mill at Cobham)'.[46] Other readers of *Alexander Raby, Ironmaster*[47] had also concluded that Raby had moved beyond the manufacture of iron plate, bar and hoops into a range of utensils for the burgeoning 'domestic household' market in late 18th century London, such as tinned pans and boot-scrapers. There seemed a general assumption that the copper foundry had been set up to service similar markets. However, there was no direct evidence to hand for this while Raby's earlier and later career suggested he was involved primarily in producing iron plate and bar, used in his early period for the manufacture of iron hoops for masts and barrels and the forging of such material into large items such as anchors and later track for railways. A review has therefore been carried out into the relevant references quoted in *Alexander Raby, Ironmaster* while many other sources have also been consulted.

It now seems possible that the large copper foundry at Downside was set up to meet demand for copper sheets and bolts from the Royal Navy for the newly-introduced practice of copper-sheathing of the hulls of warships.[48] After a number of years of experimentation, the Navy Board adopted proposals in 1763 for copper-sheathing of smaller warships, extending this to larger warships in the 1770s.[49] Staniforth states that by the middle of 1784 Raby was one of a number of copper contractors supplying the newly-introduced copper bolts for the sheathing.[50] The sheathing and the increasingly specialised nails and bolts needed to be replaced every few years and Raby was one of several contractors who entered into arrangements with the Navy Board to abate the price of new sheathing by an allowance

[44] Hayman 2004; King 2012.
[45] Hayman 2004.
[46] Hodgkinson 2004, 241.
[47] Crocker G (ed) 2000.
[48] Primarily to reduce fouling by barnacles and seaweed but also to counteract the destruction of timber by *Teredo navalis*, the naval shipworm.
[49] For discussions of the many scientific and administrative difficulties of this technological revolution see Knight (1973) and Staniforth (1985), both available online.
[50] Staniforth 1985, 25.

for old copper sheets and bolts returned for reprocessing.[51] These arrangements were implemented on a national basis so that old copper returned from say the Navy dockyards at Portsmouth or Plymouth could be credited against new copper sheets[52] supplied to the Navy yards at Chatham, Deptford, Woolwich and other 'Thames and River' yards – and vice versa. As an example, a Navy Board document[53] reveals that the Navy Officers at Plymouth recorded that in the six months to 24 November 1787 they had received from Raby 2594 new copper sheets of 32 ounces each (weighing nearly 11 tons) and 519 new copper sheets of 28 ounces each (weighing just over 2 tons) at an aggregate price of £1306 8s 9d. To offset this old copper sheets weighing 10½ tons valued at £782 13s 4d, had been delivered to Mr Raby together with the return of nineteen old packing casks valued at £2 17s. The Navy Officers certified that the net sum to the credit of Mr Raby was £520 18s 5d. Another document[54] issued a few days later on 11 December 1787 suggests this account was settled by the delivery of 6½ tons of old copper sheet to Mr Raby by the Chatham Yard. This document also noted that Chatham now had so much old copper encumbering the yard that they would have to send it to contractors other than Raby, unless he could let them have details of additional new copper sheets supplied against which its value could be offset. The copper sheeting may well have been made and, or, re-processed in Raby's large copper foundry at Downside Mill – although no direct evidence has been found that this was carried out at Downside, no other Raby facility in the 1780s is known to have had the capacity to do so.

To give some perspective to the delivery by Alexander Raby to Plymouth of 3113 sheets weighing *c* 13 tons in 1787 (see above) it may be noted that the re-sheathing of *HMS Victory* in 1815 required 3640 sheets at a weight of 'over eleven tons'.[55]

Returning to the question of manufacturing articles of iron at Downside Mill, *Alexander Raby, Ironmaster* contains the following extract: 'The women's shop [...] is at first surprising as women did not normally work at iron mills. However, in 1803 Raby built 'Tinmans Row' 1km to the west of the mill on Downside Common, which suggests that cast iron objects or plates were being coated with tin at the mill. The iron had to be thoroughly cleaned before being dipped in molten tin and this work was carried out by women'.[56] David Cranstone has drawn attention (via Sarah Paynter) to an article by Joseph Farey (first published in late 1811 or 1812) describing the tinning of iron, which was later included in *Rees's Manufacturing Industry* (1819–20).[57] Extracts read 'The principal part of the work is to prepare the leaves [of iron], beat out to a proper thinness, so that they shall readily receive the tin; for if there be but the smallest particle of dust on them, or only the slightest rust in any part, the tin will never fix there' and, after a detailed description of the process, 'by this means a woman cleans more [iron] plates in an hour, than the most expert workman can do otherwise in many days'. This is probably the function carried out in the 'women's shop' at Downside Mill. Crocker's reference to 'smaller pieces of ironmongery' may on occasion have been misconstrued. There seems no evidence that any of Raby's businesses fabricated articles such as tinned kitchen pots and pans for the domestic market; rather the evidence suggests that all his iron operations were based on making iron hoops for masts and barrels, iron bar, iron plate and tinned iron plate together with the forging of these into heavy items such as anchors and, in the early 19th century, for mining and railway applications.

The term 'ironmongery' used by both Crocker and Potter may have inclined readers to construe the word as used in the second half of the 20th century, ie the goods sold in a high street ironmongers' shop, perhaps better described today as a hardware store. Potter[58]

51 TNA: ADM106/1285/65.
52 Standardised over time at 32 ounces and 28 ounces.
53 TNA: ADM 106/1291/133.
54 TNA: ADM 106/1289/267.
55 Knight 1973, 308, fn 12 gives the documentary sources.
56 Crocker, A, 2000, 24.
57 Cossons 1972, **3**, 187–91, 196–7, 202.
58 Potter 2000, 12, following his earlier paper in *Industrial Archaeology Review*, VI, 3, Autumn 1982.

states that in 1800 'Raby is known to have had a partnership in a shop at 31 Greek Street, Soho, where his manufactured articles were sold'. Jenkins[59] correctly identifies the Raby at 31 Greek Street from 1799 to 1808 as George Raby. An ironmongery business had existed at 31 Greek Street for some years, being owned by a Jonathan Buttall who is recorded as having the business in 1788[60] before it was acquired by a partnership of Nicholas Mann Jackson and George Raby. This partnership ran two businesses, the first being a 'salecloth [*sic*] manufacturer' at premises in New Road, St George in the East, Stepney and the other being 'in the Business of Ironmongers' at 31 Greek Street.[61] The partnership stationery states that Jackson & Raby, carrying on the ironmongers' business formerly known as Buttalls, dealt in 'Bar-Iron, Hoops, Rods, Plate Iron, Steel and Ironmongery of all Sorts'.[62] This partnership was dissolved on 31 March 1798[63] with all debts owing to the partnership to be paid to George Raby's 'Compting-House' at 31 Greek Street. Sales invoices (on the old partnership stationery) issued in 1800 by George Raby to Messrs Wedgwood of London – the pottery company who had their London Showroom in Greek Street – include 'Sheet Chest Plate, Flemish Tacks, Clouts, Screw Drivers, Sand paper, Clasps, Spikes, tin'd tacks and Brass head nails'.[64] A receipted handwritten invoice dated 1802 to Wedgwood & Byerly details similar items supplied by George Raby.[65] There is no mention in these invoices of items such as tinned pots and pans or other domestic wares.

Buttriss[66] describes George Raby as a brother of Alexander whereas Jenkins[67] refers to him as 'possibly a nephew?'. It has not so far been possible to resolve the actual relationship between Alexander and George Raby through the usual genealogical sources. However, the transcript of a trial at the Old Bailey in 1782[68] records a George Raby appearing as a witness and declaring that he is the brother of Alexander Raby, a manufacturer of iron hoops. It is clear from the evidence given that George was familiar with the manufacturing and sale of iron hoops. It is likely, in view of the close connections between Alexander Raby and the Wedgwood family,[69] that the George Raby trading as an ironmonger in Greek Street is Alexander's brother.

Alexander Raby and George Raby had run at least one business as 'iron merchants' in Allhallows Lane and at 15 Bush Lane as a partnership between them; this partnership appears to have been in existence by 1792[70] and was dissolved on 27 June 1794[71] with the instruction that monies due to the partnership were to be paid to Alexander Raby's 'Accompting-House' at Allhallowes Lane,[72] Upper Thames Street who would be continuing the business as a sole trader.[73]

[59] Jenkins 2000.
[60] LMA: CLC/B/192/F/001/MS11936/351/539949.
[61] *The Gazette* 29 May 1798, 473.
[62] V&A/Wedgwood Collection MS No 25491–128.
[63] *The Gazette*, 29 May 1798, 473.
[64] LMA: CLC/B/192/F/001/MS11936/351/539949.
[65] V&A/Wedgwood Collection MS No 25494–128.
[66] Esher & District Local History Society Monogr, **11**, Aug 1985, page 4.
[67] Jenkins 2000, fn 5.
[68] Proceedings of the Old Bailey 1674 to 1913, t17820911-19, accessed online at https://www.oldbaileyonline.org/browse.jsp?div=t17820911-19 on 15 January 2017.
[69] Taylor 2000, 15–16.
[70] Jenkins 2000, fn 7.
[71] *The Gazette*, 1794.
[72] Jenkins 2000. Alexander Raby, alone or in partnership with others was at 9 Allhallows Lane from at least 1785.
[73] *The Gazette*, 1794 – this reference may have been unknown to Buttriss or Potter.

Location of the archive

The archive of the Downside Mill excavation is divided into three parts: the physical archive (the finds), the paper archive (the context sheets, site drawings and all paperwork relating to the project), and the digital archive (text files, spreadsheets and images). The physical archive and the paper archive are held by Elmbridge Museum (acc no 1.2017). The digital archive is held by Elmbridge Museum and the Archaeology Data Service – see *Endnote*. The fragments of the cast blocks of slag from Coxes Lock, Addlestone found in 2009 are deposited with Chertsey Museum.

Endnote

The information listed below is available on the Archaeology Data Service website:
website: https://doi.org/10.5284/1000221
Select *Surrey Archaeological Collections* volume 100 and the files are listed as supplementary material under the title of the article.
Stratigraphic report and director's commentary, by Tony Howe
Finds report, by Richard and Pamela Savage
The assessment of metalworking debris, by Dr David Starley, December 2008
Consultant's opinion, by Dr David Cranstone, May 2009

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COBPK/5/3 Conveyance of Downside Mill dated 24 May 1866 made between (1) Mrs M A Meller and Ors and (2) Charles Combe Esq

LMA: London Metropolitan Archives

CLC/B/192/F/001/MS11936/351/539949 Sun Alliance Insurance record of Jonathan Buttall being the insured, as an ironmonger, at 31 Greek Street, Soho on 22 January 1788

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ADM 106/1291/133 Plymouth Officers. Account of the new copper sheathing received and old copper delivered to Alexander Raby since May, dated 24 Nov 1787

V&A Victoria & Albert Museum/Wedgwood Collection

Presented by the ArtFund with major support from the Heritage Lottery Fund, private donations and a public appeal (the documents referred to below were formerly held by the University of Keele Library)

MS No 25491–128, Jun 1800 Receipted invoice from George Raby to Messrs Wedgwood on headed stationery of the former partnership between Raby and Jackson – amended by hand to delete Jackson

MS No 25494–128. Sep 1802 Receipted invoice, handwritten on ledger paper from George Raby to Messrs Wedgwood and Byerly

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