New Low Head Turbine Installation

Mapledurham Watermill South Oxfordshire

Archaeological Watching Brief Report

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Archaeological Watching Brief Report

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Illustrated by Conan Parsons and Julia Collins

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Summary

Between May and August 2011 Oxford Archaeology undertook an archaeological watching brief during the removal of an early 20th century turbine installation and the construction of a modern low-head turbine at Mapledurham Mill, Mapledurham, Berkshire.

The watching brief observed details of the 1922 turbine installation, and several phases of mill race construction associated with the 18th and 19th century expansion of the mill. No in situ evidence was encountered for mill races or structures pre-dating the 18th century mill. Elements from previous phases of the mill's construction were recovered from ground raising dumps that had been used to raise the ground level on the island to the south of the mill during the remodelling of the southern mill race channel. This included fragments of a waterwheel, including wooden parts and iron fittings, probably from the wheel that was removed in 1922.

1 INTRODUCTION

1.1 Scope of work

1.1.1 Planning permission was granted to Mapledurham Estate to replace the existing, non-working and derelict electricity turbine housed with one of a proven modern design. This scheme involved the demolition of the existing turbine and plant rooms, alteration of the waterways, installation of a new turbine and sluice with a new walkway, and a replacement pedestrian bridge (Planning Ref: P09/E0902). As the building is a Grade II* Listed Building (PRN 1400) a separate Listed Building Application was submitted and granted (Planning Ref: P09/E0903/LB).

1.1.2 Due to the potential for disturbance to below ground archaeological remains a condition was attached to the full planning permission. In line with Planning Policy Statement 5 (2010) and Local Plan Policies a brief was prepared by Richard Oram of Oxfordshire County Council Archaeological Service on behalf of South Oxfordshire District Council Planning Archaeological Services (Oram 2011), which required an archaeological Watching Brief to be maintained during the period of groundworks.

1.1.3 Oxford Archaeology were commissioned by Mapledurham Power Partnership to undertake the watching brief, which was carried out in accordance with a Written Scheme of Investigation (OA 2011) that satisfied the brief.

1.2 Location, geology and topography

1.2.1 Mapledurham Mill (Plate 1) is located on the western side of the village of Mapledurham, on the northen bank of the River Thames (SU 6693 7674) and is currently operated as a functioning restored undershot watermill. It lies at approximately 39.5m aOD with the underlying geology recorded as alluvial deposits overlying River Terrace Gravels (BGS).

1.2.2 The present building is accessed from the north-eastern bank of the River Thames and is situated on a small island between two mill races. A larger, undeveloped island lies beyond this. The races are formed by a single mill leat which comes off the main course of the Thames further upstream and splits after widening into the mill pond immediately upstream from the mill building. The northern race, which separates the river bank from the mill, or the 'bankside' of the mill, contains a restored waterwheel which drives the

mill. To the south of the mill is the southern race, which contained the defunct turbine; this is referred to as the 'islandside' of the mill. After passing the mill building, the two races reconnect in the large, pond-like mill tail from which a leat channels the water back to the Thames further downstream. The head of water needed to power the mill, and stored in the mill pond, is created by a large weir on the main channel of the Thames with the prerequisite lock to allow passage past the weir for river craft. The site is listed Grade II* (PRN 1400), and is situated within the Mapledurham Conservation Area. The grouping of Mapledurham House, the Old Manor House, church, almshouses, the Mill House, and the watermill, along with associated cottages and grounds, are together considered to be of national importance by English Heritage.

1.3 Archaeological and historical background

1.3.1 This section presents a digest of the archaeological and historical information presented in the Conservation Statement (Carlisle and Miles 2010) and the historical and evidential notes attached therein.

1.3.2 There is reference in Domesday (1086) to a watermill at Mapledurham. The watermill was one of a complex of buildings that developed on the site over the centuries. Historically, the watermill and its facilities were provided for use by both the owners and the villagers. Of the three historic channels for water power, only one remains in use. The mill has been subject to changes in both function and design, some rapid and others more gradual, all with the overriding purpose of utilising a reliable source of water power. The complex is known to have incorporated an early lock, weir and wharf, the Mill House and associated cottages, a malthouse and granary.

1.3.3 The current watermill is not only the last working watermill on the Thames, it is also the oldest surviving mill in the region. The mill is a rare example of an estate mill that can potentially trace its history back to well before 1280, partly due to the fact that it has always been within the Mapledurham Estate. The earliest known depiction is the 1587 Blagrave map, which shows a somewhat unclear building on the site, but the scale is insufficient to work out any details; a damaged copy of approximately the same date shows a waterwheel on the island side.

1.3.4 Despite the documented medieval origins for the mill, nothing is considered to survive above ground from before the 17th century. The core of the present structure has been dated through dendrochronology to 1626 (Miles *et al.* 2009) and consists of a timber-framed central core of three bays which had an undershot waterwheel at each end. This coherent core probably represents a major phase of rebuilding of the mill and can be put in context with the broader estate-wide rebuilding campaign undertaken during 1610-1625 by Sir Richard Blount (1564-1628). More than 13 buildings have been identified as having been constructed during this period, including the present Mapledurham House, Chazey Court, and the almshouses, with the watermill the latest to be attributed to this campaign.

1.3.5 Many of the visible remains date to the 18th century, when the mill was adapted to full cloth in addition to grinding flour. This dual purpose was typical in mills of the middle Thames region and would have required new machinery and the rearrangement of the existing equipment. Dendrochronology and the data from documentary sources has been used to show that the malthouse was probably constructed after 1723. The granary was erected in 1777 adjacent to and extending over the malthouse. At the same time a new barn or granary was built on the larger island to the south of the mill. Upstream of the watermill on the riverbank side is a brick and jettied timber-framed

extension, tree-ring dated to 1764-5 (Miles and Haddon-Reece 1995), which was subsequently enlarged. This served as a wharf from the mill stream.

1.3.6 Later construction and maintenance work is known to have included a brick enlargement of the north-east upstream wing and in the mid 19th century the sluice gates were renewed on the island side, and a dendrochronological date of winter 1856-7 for one of the sluice gate support timbers (Miles *et al.* 2009). Prior to 1898, the malthouse was demolished and a much larger storage building constructed on its site.

1.3.7 The construction of the 1922 turbine house involved the demolition of the twin mill races on the south (island) side of the mill and the construction of a concrete chamber immediately downstream of the sluice gates, the single remaining waterwheel on that side having been removed a couple of years previously. The turbine itself was covered by the new turbine house. This was roofed in corrugated asbestos and the downstream elevation was a combination of concrete and timber boarding. Problems with the turbine and its ability to function have been intermittent, hence the need to replace the old workings with a new screw turbine better suited to the conditions.

1.3.8 A fire in 1955 destroyed the old granary as well as most of the turbine house and the covered bridge to the mill. In 1979, planning permission was granted to restore the granary and dovecote, and foundations were laid for some of the granary building.

1.3.9 The mill featured in the film *The Eagle Has Landed* in 1976 and it was the revenue resulting from this that enabled completion of the restoration work and milling to recommence after a 40 year hiatus.

2 Project Aims and Methodology

2.1 Aims

2.1.1 The aims of the watching brief were:

(i) to preserve by record any archaeological deposits, structures or features encountered during the course of ground intrusions;

(ii) to seek to establish the extent, nature and date of any archaeological deposits, structures or features encountered within the scope of the ground intrusion;

(iii) to secure the analysis, conservation and long-term storage of any artefactual/ecofactual material recovered from the site;

(iv) to disseminate results through the production of a grey literature report.

2.2 Methodology

2.2.1 The methodology was as detailed in the Written Scheme of Investigation (OA 2011).

2.2.2 The watching brief focused on investigations and observations after the initial demolition of the turbine house had taken place, during subsequent groundworks that had the potential to impact on the below ground remains of the watermill complex. These works included:

- The removal of the 1922 turbine chamber and any associated structures. Prior to removal of the chamber, a combined temporary coffer dam and access road consisting of clay packed between two lines of steel piles was constructed across the mill race *c* 25m west of the mill (Plate 2). After the dismantling of the sluice gates, the concrete apron that formed the floor of the throat leading into the

turbine chamber was broken up and the sides and floor of the turbine chamber were demolished (Plate 3);

- The lowering of the mill race bed prior to the construction of the floor of the new turbine installation. The level was lowered by *c* 0.3m at the headrace end, increasing to *c* 1.2m at the tailrace end;
- The pulling back of the mill race sides to facilitate the erection of scaffolding and shuttering prior to pouring the new turbine chamber sidewalls. The sides of this excavation were battered back for reasons of safety, from *c* 1.2m wide at the base of the excavation to *c* 2.5m at the top;
- The construction and reinforcement of the northern mill race throat.

2.2.3 The majority of the excavations were undertaken by a mechanical excavator fitted with a variety of buckets. Both the excavation and spoil were closely examined for evidence of earlier structures, deposits or features.

2.2.4 A record consisting of a plan, sample sections and photographs was maintained during each phase of work. Recording was carried out in accordance with established OA practice (Wilkinson 1992). All contexts were allocated unique numbers, as were small finds. Bulk finds were collected by context. Digital colour photographs and black-and-white negative photographs were taken of all recorded features, sections and notable finds. A working record of the construction process was also complied.

2.2.5 Provision was made for taking environmental/organic samples in accordance with OA environmental procedures.

2.2.6 Site plans were drawn at an appropriate scale (normally 1:50 or 1:100) with larger scale plans of features as necessary. Section drawings of features and sample sections of trenches were drawn at a scale of 1:20. Scale drawings (at 1:10) were also made of the recovered timbers.

3 RESULTS

3.1 Description of deposits

The mill race throat (Fig. 2, Plate 4)

3.1.1 Within the throat leading into the turbine chamber, removal of the concrete apron forming the floor of exposed a layer of mid grey sandy clay silt (1). This deposit contained quantities of abraded chalk and broken red ceramic roof tile. Later excavation showed it to be 0.52m thick. Driven into this deposit were a number of square, iron-shod oak piles (103, 104, 107 and 110). These piles were all similar in appearance and supported the walkway which ran across the mill race to the east of the sluice gates. The concrete apron (2) that formed the floor of the throat leading into the turbine chamber had been cast *in situ* around the piles.

3.1.2 The eastern extent of both layer 1 and the concrete were contained by a wooden structure (3) that extended across the width of the mill race, perpendicular to the mill (Fig. 2, Plate 4). As well as forming a retaining wall for the mill race throat, this structure also acted as a sill against which the bottom of the sluice gates butted. It consisted of a large beech beam laid horizontally and extended for the full width of the mill race, with the north end of the beam socketed into the mill wall. A line of wooden sheet piles (129, 130, 131, 132, 133 and 134) had been driven in and secured to the western side of the beam. The beam measured approximately 0.35 x 0.31m in profile and was 4.1m long. It separated into two pieces during lifting (111 and 135). The line of wooden sheet piles

consisted of beech planking 0.078m thick and 0.22m wide with the bottom end asymmetrically pointed and clad in a sheet iron shoe. They had been driven in vertically and were secured to the beam using 6 inch long wrought iron nails.

3.1.3 Immediately below the northernmost sluice, a second beam (112) measuring 1.76m long by 0.34m wide and 0.2m deep had been secured to the top of the horizontal beam using a mixture of spikes and treenails. This may represent a working repair to the base of the sluice.

3.1.4 There is a step of *c* 0.75m in the level of the mill race bed between the head race apron and the base of the turbine chamber. This had been retained by a line of short wooden iron shod piles (3) that extended across the width of the channel. The wooden jamb of the northern sluice gate (112) appears to have been spiked (nailed) to the top of the wooden piles, but the tops of the piles had deteriorated and so this was not certain.

3.1.5 Removal of the southern sidewall of the existing chamber exposed a loose deposit of light yellowish grey clay silt (30). This deposit was the backfilling of the gap between the concrete sidewalls of the turbine chamber and the construction cut. Contained within this material was a large quantity of fragments of tile and brick (similar to that found within layer 1), together with a number of iron objects including nails, spikes, chain, two curved iron plates which appear to be reinforcing plates for the side of a waterwheel (142 and 143), and two wooden starts (or spokes) from a waterwheel similar to the surviving wheel (140 and 144, Fig. 6).

3.1.6 Part of a stave revetment of oak was also seen *in situ* along the north bank of the north head race. It comprised It comprised vertical staves attached to a horizontal whaler (142). Some of the staves had snapped near their bases.

The turbine chamber (Fig. 3)

3.1.7 Following the breaking out of the concrete floor of the existing chamber, the base was excavated to accommodate the lower, sloping base of the new chamber. This involved reducing the level by *c* 0.3m at the headrace end, increasing to *c* 1.2m at the tailrace end. Structure 3, the combined revetting and sluice gate base, was also removed during this phase.

3.1.8 The earliest deposit exposed was a compact layer of sub-angular chalk nodules with small sub-angular flints (16), which was exposed in the eastern part of this excavation, where it was dug into to a depth of 0.5m without reaching its base. No dating evidence was recovered and it was unclear whether the layer was the underlying natural geology or a deposit within the base of the river.

3.1.9 Layer 16 was overlain by layer 8, which was exposed directly beneath the base of the existing chamber. It was a very pale grey/white deposit composed almost entirely of small-very small lumps of chalk and small sub-angular flints mixed together with silt and gravel. It was 0.5m thick and no dating evidence was recovered.

3.1.10 Breaking out of the southern side wall and base of the turbine chamber exposed a layer of semi-compacted mixed chalk and light grey silts (7) beneath the concrete floor. This deposit was very similar to layer 8 and it was unclear whether it was a levelling layer or an earlier channel bed.

3.1.11 The 1922 turbine chamber (4) consisted of a concrete floor forming the base of the tail race, the mid floor containing the opening for the inlet side of the turbine, the side walls and a short central wall running up to the edge of the turbine.

The mill race (Figs 3-5, Plate 6)

3.1.12 The pulling back of the mill race sides exposed the sequence of build-up for the island, together with details of earlier phases of the mill race side wall construction (Figs 3-5).

3.1.13 At the base of the excavation the layer of compacted chalk (16) was exposed that was in excess of 0.4m deep (Figs 3-5). This was overlain by a layer of dark grey clay silt (14) that was up to 0.8m thick that was retained at its eastern end by a line of wooden stakes (19). These were roughly dressed lengths used in the round with an axe- or adze-trimmed point. The line of posts ran N-S, extending into the bank and up to the edge of the mill race, possibly revetting the eastern edge of the island. The deposit produced quantities of small to medium sized lumps of chalk and sub-angular flint, together with fragments of ceramic roof tile, as well as numerous timbers that appeared to have been reused as part of the revetting or lacing within the deposit (108, 113, 116, 117, 136 and 137).

3.1.14 A platform or lacing comprising regularly spaced lengths of round timber (22) was laid horizontally on the surface of layer 14. A heaped layer of olive-grey clay silt (13) was built directly upon this timber and was retained by the line of posts (19). The deposit was up to 1.4m thick and contained lumps of chalk and flint, as well as with fragments of ceramic peg tile.

3.1.15 A second line of posts (20), also aligned N-S, was situated *c* 5m east of revetment 19. This line consisted of large roughly dressed oak posts (121, 122, 125) that were each 0.25-0.3m in section and up to 4.5m in length. It retained a 1.6m thick layer of light grey clay silt (15) that had been laid directly on the compacted chalk (16) and butted against the earlier revetment 19. This layer contained timbers that may have been reused as part of the revetting or lacing (101, 102, 105, 106, 109, 114 and 115).

3.1.16 A line of wooden sheet piles (21) had been driven into layer 15 (Figs 3, 5 and 6). The sheet piles (118, 119, 120, 123, 124 and 131) were aligned N-S and their alignment corresponded with the location of an isolated pile (131) on the northern side of the tailrace, suggesting that they may have formed a coffer dam across the end of the tail race.

3.1.17 A line of 1.25m long beech piles (23) had been driven into the surface of layers 14 and 15 and supported a brick wall (6; Figs 3 and 4, Plate 6). The piles were each *c* 0.22m in diameter and had roughly hewn points. Wall 6 was 0.47m wide. Built using hand moulded red bricks 0.23m x 0.105m x 0.066m and lime mortar, it was constructed using English stretcher bond and ran the length of the tailrace, a distance of 6.5m. Parts of it survived up to 1.5m in height, but at the western end, adjacent to the sluices, it had been truncated in height by the construction of the 1922 turbine chamber.

3.1.18 Overlying layer 15 and butting up to the back of wall 6 was a layer of light grey-brown clay silt (12), up to 1.2m in depth. This deposit contained quantities of sub-angular chalk and fragmented red ceramic roof tile. Its eastern extent butted up to the line of wooden posts (20). A layer of dark grey-brown silt clay loam topsoil (11) had accumulated above layer 12 to a depth of 0.25m. This layer ran up to and over the eastern edge of the island.

3.1.19 As part of the machining operation a temporary layer of made ground (10) was laid over the topsoil (11) to create a platform for the machine to stand on. The side of the island was also cut back, during the course of which a number of stratified and unstratified timbers were recovered from layers 12, 15 and 30 (see timber inventory, Appendix B). Some of the timbers were plain roughly trimmed stakes and piles, but

working on some of the other timbers suggest that they may originally have formed part of the mill structure.

3.2 Finds

Ceramic Building Materials

by John Cotter

3.2.1 The CBM assemblage comprises 11 pieces weighing 2466g from two contexts (Table 1). This was examined and spot-dated according to standard Oxford Archaeology procedures and the data recorded on an Excel spreadsheet. The dating of broken fragments of ceramic building materials is an imprecise art and spot-dates derived from them are necessarily broad and should therefore be regarded with caution.

3.2.2 Nearly all this material comprises fairly large fresh and worn fragments of flat roof tile (peg tile) of typically rectangular form with a pair of circular nailholes near the upper end. They occur in a limited variety of sandy and smoother pinkish- and orange-brown fabrics with varying amounts of cream and red clay pellets and clay streaks. One example retains a complete width of 153mm. The irregularity of the tiles and their noticeable thickness suggests they are of medieval date: broadly 13th-16th century. A single piece of curved roof tile from context 15, possibly a ridge tile, appears to have a smoother denser fabric and may be post-medieval in date. Further details are recorded in the spot-dates spreadsheet.

Table 1: Quantification of ceramic building material

Context	Spot-date	Sherds	Weight (g)	Comments
13	13-16C?	9	2235	Large frags from min 7 peg tiles - all probably med w circular nail holes. Mostly in sandy orange-brown fabric with varying amounts of cream-coloured marl pellets and streaks and red iron-rich clay pellets. Include *c* 2/3 complete tile from lower part with complete width of 153mm, thickness 17-18mm, surviving length 185mm. white mortar traces on 1 side, sanded underside. One long edge of the latter seems to have been deliberately chipped/worn - poss used in a wall or on-edge floor? one is in denser smoother fabric but might still be med
15	17-19C?	2	231	Fresh bodysherd from curved ?ridge tile or pan tile in smooth dense pinkish-brown fabric - prob post-med. Edge frag orange peg tile with crude circular nail hole - prob med
Total		11	2466	

***Metal objects** by Ian Scott*

Introduction

3.2.3 There are 107 iron objects (112 fragments) from three contexts (Table 2). There are no other metals present.

Table 2: Summary quantification of the metalwork assemblage by context, function and object identification

		Context			
Function	Identification	1	15	30	Total
Structural	strapping			2	2
	bar or tie			1	1
	bolts, type T1	4	1	3	8
	bolt, type T2			1	1
	bolts, type T3	3		1	4
	bolt, type T4	2	2		4
	bolt, domed head	1		2	3
	bolt, rectangular head			1	1
	bolt, incomplete		1		1
	washers	3			3
	hinge strap			1	1
	holdfast			1	1
	joiners dog		1		1
	U-staple	2	4	1	7
	Total	15	9	14	38
Nails	nail	7	14	3	24
	nail, ?chisel point			1	1
	nail, broad chisel point	1	2		3
	nail, chisel tip	11	13	1	25
	Total	19	29	5	53
Security	chains			2	2
	Total			2	2
Tool	File			1	1
	Pincers or clamp			1	1
	Total			2	2
Measure	Weight			1	1
	Total			1	1
Miscellaneous	Bar	3			3
	Bar or strip			1	1
	Block		1		1
	Plate	1			1
	Ring	1			1
	Strip	1			1
	Wire			1	1
	Total	6	1	2	9
Query	Block/object			1	1
	Wedge		1		1
	Total		1	1	2
	Total	40	40	27	107

Assemblage composition and provenance

3.2.4 The assemblage is very distinctive and dominated by nails (n=53, fragments n=57) and other structural fittings (n=38, fragments n=38). Other functional classes are either absent or sparsely represented. The material was recovered from just three contexts (1, 15 and 30).

3.2.5 The composition of the metalwork assemblages from contexts 1 and 15 appear to be similar and differ slightly from the assemblage from context 30. Contexts 1 and 15 each produced 40 objects, which are almost exclusively limited to structural fittings, nails and miscellaneous items, with the addition of a single iron wedge from context 15. However, context 1 has more structural fittings and miscellaneous items and fewer nails than context 15. Context 30 has a similar number of structural fittings to context 1, but yielded a wider range of types. The structural fittings from context 30 include two curved pieces of strapping that may be from waterwheels, a number of bolts, a holdfast and a possible hinge strap. Context 30 has far fewer nails than were found in either of the other two contexts. It also has two pieces of chain and the only two tools.

Objects by function

Structural fittings

3.2.6 The structural fittings include two curved strapping elements, both from context 30. The larger example (142) is 690mm long and 85mm wide, has two certain bolt holes, and probably four, spaced at intervals of *c* 200mm. It may be part of the structure of a waterwheel. The smaller strapping (143) comprises two curved strips (390mm and 395mm long and 58mm wide) with four bolt holes in each. The two strips are held together by four nuts and bolts. The spacing between bolt heads and nuts are 145mm, 150mm, 147mm and 145mm for the four bolts. This strapping element is also curved and therefore almost certainly was attached to a curved object, possibly a waterwheel or gear wheel.

3.2.7 The most common fittings are bolts. Most are of a similar length, usually between 110-125mm long, although there are some longer examples, and the majority have T-shaped heads. Most of the bolts have stem diameters of 13-14mm.

3.2.8 Type T1 bolts (n=8) have a T-head with the tapered ends bent down or clenched. The heads range in length from 73-77mm.

3.2.9 Type T2, T3 and T4 bolts have a shorter T-head which does not taper to points. The three types are distinguished by the size of the head. The single example of T2 has a head which measures 66mm in length. The examples of Type T3 heads (n=4) measure between 48-52mm in length, and Type T4 heads (n=4) measure between 31-38mm in length. It is possible that the Type T1 bolts served a different purpose from the other T-headed bolts, since the clenched ends would have given extra grip. The key element is that all the bolts are hand wrought and not machine made. A few of the bolts had square nuts attached, and one had a nut and a washer attached

3.2.10 There are a few other bolts with simple circular domed heads and an example with a rectangular head. Two of the bolts attached to curved strapping strips 143 from context 30 have square heads, one example more domed. Another bolt has a small flat square head and the fourth bolt has a domed sub-square head. All four bolts had square nuts.

3.2.11 Other structural fittings include washers, a possible hinge strap, a possible holdfast, a joiner's dog and seven U-staples.

Nails

3.2.12 The nails from all three contexts are distinctive in two ways. Firstly, the majority of nails are over 100m long. The nails most commonly found on archaeological sites are small wood nails measuring predominantly 2, 3 or 4 inches long (ie. *c* 50mm, *c* 75mm and *c* 100mm). Longer nails are not common. Only 13 of the 48 complete nails are less than 100m long. The remaining 35 nails are all larger than 100mm and seven are in excess of 200mm long. The longest nail (context 30) is 450mm long.

Table 3: Summary quantification of nails by length and context

	Context			
Nail length	1	15	30	Total
50	1			1
57		1		1
58		1		1
64	1			1
65			1	1
68	1	1		2
71	1			1
85		1		1
86		1		1
90		2		2
97	1			1
<100mm	5	7	1	6
105	1	1		2
108		2		2
116		1		1
130		1		1
133	1			1
138	1			1
140		2		2
147		1		1
149		1		1
101-250mm	3	9		6
152		1		1
155		1		1
156			1	1
159	1			1
162	1			1
163	1	1		2
164	1			1
167	1			1
170			1	1
172	1			1
175		2		2
182	1			1
184	1			1
186			1	1
195		1		1
151-200mm	8	6	3	6
205		1		1
220		1		1
228	1			1
240		1		1
330	1			1
450			1	1
200mm+	2	3	1	6
Total	18	25	5	48

3.2.13 The second distinctive feature of the nails from the site is that more than half have chisel–like points. The chisel points include three very distinctive nails with broad flat chisel points (lengths 85-95mm).

3.2.14 Excluding the broad chisel points there are 25 (or 26) complete nails with chisel-like points. These are predominantly longer than 150mm. Only ten are shorter than 150mm, 12 are between 151-200mm long and four are longer than 200mm. By contrast, of the 19 complete nails with stems tapering to simple points, 12 are less than 150mm long, five are between 151-200mm and only two are longer than 200mm.

3.2.15 The presumption must be that large proportion of large nails reflects the fact that the recovered metalwork was derived from the structure of the watermill. Large nails were required for use with the heavy timbers necessary in a structure of the mill and its machinery. The distinctive chisel points must also be related to the use of the nails in the mill structure.

Other finds

3.2.16 Other metal finds from the watching brief are limited. They include a half-round file and a pair of distinctive pincers or clamps with toothed jaws, both from context 30. The remaining metalwork is largely made up of miscellaneous fragments, of iron rod, sheet and strip.

Conclusions

3.2.17 The metalwork assemblage has a coherence in its composition, comprising numerous distinctive bolts, large nails of distinctive form, limited extraneous items and no domestic objects. This suggests that it represents a dump of structural metalwork probably derived from the watermill.

Glass

by Ian Scott

3.2.18 There is a single piece of glass: the base of a mould blown later19th century cylindrical wine bottle from context 15. The base has a conical kick, and the metal is thick dark olive green.

3.2.19 The absence of more than this single piece of glass reinforces the supposition that the material deposited in context 15, and by extension in contexts 1 and 30, was structural material that had been deliberately and carefully deposited. The lack of glass suggests an absence of domestic or general rubbish.

Wood objects

by Damian Goodburn

3.2.20 A large number of fragments of timber were recovered during the construction work (*c* 100), of which 46 were considered significant and recorded in detail. Examples of these are shown on Fig. 6.

3.2.21 The timbers were examined during a site visit on 12/7/2011. It was possible to group some of the timbers together on the basis of species, water wear, Jointing and fastenings. Some of the key apparent groups were as follows.

3.2.22 Circular sawn beech staves (130, 132 etc, Structure 3) with metal folded tips, many of which derived from a 'step' in the tail race. It seems likely that these staves were fitted when the 1922 turbine was fitted.

3.2.23 Another group, also from Structure 3, comprised two large, squared but very eroded beams that had run across the wheel pit, one on top of the other, with the sluice gates closing against them. The lower beam (135) was of beech while the upper member was possibly of tropical hardwood. The work again may well be of 1920s vintage.

3.2.24 A group from layer 15 comprised a grid-like construction of large oak beams, halved over each other and fastened with one oak peg and one iron spike at each joint (105, 106, 109, Fig. 6). Most of the surfaces of this group were water-worn. The location of a beech support chock suggested that this assembly was originally set vertically to one side of the wheel pit or in a nearby section of the head or tail race. The assembly had been repaired with asphalt. It could well be of 18th-early 19th century workmanship. Timbers 105, 106, 109 could be fitted together, suggesting that they formed part of the same structure. However, they were recovered in isolation. It has been suggested that the structure from which they originated had been sawn into short lengths (*c* 1.5m) to aid dismantling and that the timbers were then reused as revetting.

3.2.25 A group of three round beech piles (126, 127, 128) were found under brick wall 6.

3.2.26 Another group was a scatter of oak piles (121, 122, 125) with iron shoes that all looked late 18th century or later. Pile 122 is illustrated in Fig. 6.

3.2.27 Part of a stave revetment of oak was also seen *in situ* along the north bank of the north head race. Although a very old style of construction, a date of 18th-early 19th century seems likely because of the preservation, although an earlier date is not impossible.

3.2.28 Timbers 140, 141 and 144 (Fig. 6) were a group of three jointed timbers of oak heartwood, probably cut down from larger sections of oak timber. Water abrasion has removed all tool marks, so the method of conversion can not be determined. Timbers 140 and 144 were near-identical, the minor differences being due to differential erosion. They were each *c* 0.8m long and 75mm square at the widest point. They comprised a *c* 200mm long, 25-30mm thick tenon pierced by one eroded peg hole then a 600mm length that tapered down somewhat from the shoulder of the tenon. The thicker section was in turn pierced by four small through peg holes of 20mm diameter, most of which had been much enlarged by erosion. Timber 140 had a slight step eroded in one edge and two small rose-headed nails. The two surviving pegs did not appear to be of oak. The surviving tenon fragment 141 was of very similar proportions to the complete timbers and appeared to be of similar origins but was pierced by two eroded peg holes.

3.2.29 These pieces were ‘starts’ (short radiating supports for the paddle planks) from a water mill drive-wheel. The tenons at the ends would have fitted into paired rims of a substantial wheel and the pattern of fastening suggests that two boards would then have been pegged to each start to form the paddle assembly. In this case, it was later repaired with iron nails. The 1977 version of the wheel at Mapledurham is depicted in Vince 1978, where the starts are almost identical but with metal bolts instead of pegs. The three timbers would appear to be of probable late post-medieval date.

3.3 Dendrochronology

by Dan Miles

3.3.1 During the removal process of the concrete footing for the 1923 turbine house, a large number of timbers were uncovered. Some were in context and related to structures relating to the earlier waterwheel and sluice gate, but most were timbers used as back fill behind the concrete retaining walls on the island side. All of the timbers excavated were retained and stored on the island. The dendrochronological analysis was commissioned directly by the Mapledurham Estate as part of a long-term project being undertaken on the Estate buildings.

3.3.2 The timbers were all subjected to a dendrochronological assessment that looked at the number of growth rings, species, and presence of sapwood and ideally bark edge. A total of 22 samples were considered to have some dating potential and were sampled once the timbers had been recorded. These were numbered mm53 to mm74. Some also had context numbers that were ascribed by OA and some timbers with no OA numbers were given numbers by Corrie Starling who kindly sampled the timbers with a chain saw. Unfortunately during the intervening period the hot weather caused the sapwood to dry out and collapse, resulting in the loss of an unknown number of sapwood rings to the bark edge.

3.3.3 Using standard dendrochronological procedures (English Heritage 1998), 10 out of 22 timbers sampled dated (Table 4). Three timbers were found to match together, and were combined to form two-timber means: mm545, mm607, and mm612. The earliest timber is mm70, which produced a felling date range of 1338-70. Four other timbers, mm58, mm68, mm69, and mm73 dated from the early 1740s, with one precise felling date of winter 1745/6 for mm69. This relates to the construction of the downstream wing of the mill built with timbers felled between autumn 1745 and spring 1746. Sample mm53 is from a timber sill beam found on the western side of the old turbine house adjacent to the old dovecote building. This dated to about 1775-6 (the sapwood was partly degraded, and the completeness of the outermost ring was uncertain). This date relates to the rebuilding of the granary adjacent in 1777.

3.3.4 Finally, timbers mm57, mm60, and mm67 relate to a later unknown phase of construction on the island in the early 19th century with felling date ranges of 1811-43, 1812-44, and 1817-18, the latter probably being the most likely felling date range for the group. One timber, mm64, dated slightly later to 1769-1801.

3.3.5 One timber not processed was found to be of sycamore, and several others of beech.

3.3.6 Several timbers comprising a base frame failed to date despite having reasonable ring counts.

Table 4: Summary of tree-ring dating

Sample number	Type	Timber and position	Context/ structure	Dates spanning	H/S bdry	Sapwood complement	No. of rings	Mean width (mm)	Std dev (mm)	Mean sens (mm)	Felling seasons and dates/date range (AD)
mm53	s	Timber reused as sill beam		1696-1774	1753	21 ¼?C	79	1.28	0.31	0.187	*c* 1775-6
mm54	s	*Ex situ* oak timber CS3		-		H/S	76	2.66	0.94	0.253	
mm55a	s	*Ex situ* oak timber CS9/OA105		-		H/S	76	2.80	0.89	0.224	
mm55b	s	*Ex situ* oak timber CS9/OA106		-		13	37	2.21	0.72	0.224	
mm55		Mean of mm55a + mm55b		-		13	85	2.56	0.88	0.221	
mm56	s	*Ex situ* oak timber CS4/OA109		-		23	103	1.77	1.37	0.260	
mm57	s	*Ex situ* oak timber CS5/OA108	14	1743-1802	1802	H/S	60	1.84	0.88	0.305	1811-43
mm58	s	*Ex situ* oak timber CS6/OA107		1687-1733	1726	7	47	1.95	0.65	0.257	1735-67
mm59	s	*Ex situ* oak timber CS7		-		H/S	85	1.94	0.88	0.213	
mm60	s	*Ex situ* oak timber CS8/OA102	15	1730-1805	1803	2	76	1.70	0.79	0.261	1812-44
mm61	s	Sluice gate rack timber – oak timber CS11		-		16	76	1.82	0.51	0.197	
mm62	s	*Ex situ* oak timber CS12		-		13	90	2.10	0.69	0.181	
mm63	s	*Ex situ* oak timber CS13		-		H/S	83	2.16	1.29	0.193	
mm64	s	*Ex situ* oak timber CS14/OA114	15	1704-66	1760	6	63	4.29	1.24	0.266	1769-1801
mm65	s	*Ex situ* oak timber CS15		-		H/S	47	3.28	0.87	0.171	
mm66	s	*Ex situ* oak timber CS17		-			69	2.12	0.67	0.167	
mm67	s	*Ex situ* oak timber OA113	14	1761-1816	1798	18?C	56	2.76	1.25	0.317	*c* 1817-18
mm68	s	*Ex situ* oak timber OA121	20	1683-1745	1731	14?C	63	2.24	0.77	0.230	*c* 1745-6
mm69	s	*Ex situ* oak timber OA122	20	1708-45	1733	12C	38	4.30	1.74	0.206	Winter 1745/6

Sample number	Type	Timber and position	Context/ structure	Dates spanning	H/S bdry	Sapwood complement	No. of rings	Mean width (mm)	Std dev (mm)	Mean sens (mm)	Felling seasons and dates/date range (AD)
mm70	s	*Ex situ* oak timber OA137	14	1229-1329	1329	H/S	101	1.64	0.66	0.235	1338-70
mm71	s	*Ex situ* oak timber OA138		-		H/S	105	3.36	2.33	0.264	
mm72	s	*Ex situ* oak timber CS20		-			80	2.38	0.93	0.274	
mm73	s	*Ex situ* oak timber CS26		1686-1741	1728	13 ¼?C	56	1.64	0.50	0.215	*c* 1742-3
mm74	s	*Ex situ* oak timber CS27		-		12 ¼?C	61	2.06	0.40	0.168	
mm545		Mean of mm54 + mm55		-			85	2.56	0.88	0.216	
mm607		Mean of mm60 + mm67		-			87	2.18	0.73	0.282	
mm612		Mean of mm61 + mm62		-			90	2.01	0.64	0.171	

*Key: *, †, § = sample included in site-master; c = core; mc = micro-core; s = slice/section; g = graticule; p = photograph; ¼C, ½C, C = bark edge present, partial or complete ring: ¼C = spring (last partial ring not measured), ½C = summer/autumn (last partial ring not measured), or C = winter felling (ring measured); H/S bdry = heartwood/sapwood boundary - last heartwood ring date; std devn = standard deviation; mean sens = mean sensitivity*

3.4 Environmental remains

3.4.1 No material adjudged suitable for palaeo-environmental sampling was encountered during the course of the watching brief.

4 Discussion and Conclusion

4.1 Medieval period

4.1.1 No *in situ* remains were identified that dated from before the 18th century, but dendrochronological evidence yielded a felling date of 1338-70 for a single incomplete piece of worked timber (137) from layer 14 (below). It is possible that this timber derived from a medieval structure and was removed and incorporated into this made ground deposit during a subsequent rebuild of the mill, when it may have been reused as part of the timberwork within structure 19 or structure 22.

4.2 18th Century

4.2.1 There is documentary evidence to show that the mill underwent a period of expansion during the 18th century, when it was converted to full cloth in addition to grinding flour. In addition to this, the malthouse was built some time after 1723, a brick and jettied timber-framed extension was added in 1764-5 and a new granary in 1777. The felling dates of *c* 1745-6 that were obtained for timbers 121 and 122 indicate that Structure 20 formed part of this broad period of development. Its purpose was not certain, but it may have revetted the corner between the tail race and the eastern bank of the Island. It may have also served to retain the eastern extent of the made ground/ building platform for the fulling mill. The group of posts in the mill race throat may have been of similar date, if the felling date for post 107 is any indication.

4.3 19th Century

4.3.1 The pulling back of the mill race sides exposed deposits relating to the sequence of development of the edge of the island, the earliest phase of which was represented by revetment 19 and made ground layers 13 and 14. These deposits may have originally formed part of the island side of the mill race, possibly the tail race, while also supporting the hurst or bearing frame for the wheel shaft. Dendrochronological dating of 1811-43 and *c* 1817-18 for timbers 108 and 113, which were recovered from layer 14, indicated that the revetment dated from the early 19th century.

4.3.2 Revetment 20 and the associated made ground deposits 12 and 15 derived from a subsequent remodelling of the junction between the turbine chamber and the tail race. The evidence of the glass bottle fragment that was recovered from layer 15 indicates that this work took place during the late 19th century, and felling date of 1812-44 for timber 102 is consistent with this. Iit is possible that the construction of this revetment formed part of a wider programme of construction and maintenance that included the replacement of the sluice gates on the island side, which has been dated by dendrochronology to 1856-7 (Miles *et al*. 2009). Wall 6, which revetted the island side of the mill race (both tail race and head race), may also have been constructed at this time.

4.4 20th century

4.4.1 The installation of the turbine in the 1922 entailed the dismantling of the southern waterwheel and the construction of the concrete turbine chamber (4) within the old mill race.

4.4.2 In order to cast the floor of the turbine chamber it would have been necessary to construct a coffer dam between the island and the standing mill, of which structure 21 may be the remains. The remnants of this dam survive in the form of wooden sheet piles (118), (119), (123) and (131), which formed a straight line running transversely across the tail race. A similar coffer dam must have been constructed across the upstream side of the mill, possibly along the western edge of the concrete apron, but no evidence for this was observed during the watching brief.

4.4.3 It is probable that the bottom of the mill race was lowered and levelled prior to the casting of the chamber floor. Layer 7, which was exposed following the breaking out of the chamber floor, was very clean and may represent the underlying natural chalk, or possibly waterborne deposits. A trial pit excavated before the lowering of the tail race for the modern turbine installation demonstrated that this deposit was more than 0.5m thick.

4.4.4 Layer 1, which was exposed after breaking out of the head race apron (2), was a mixture of silts and probable demolition debris. It may possibly have been part of the original silting within the mill race but it is more likely that it represented a levelling layer of material spread over the bed of the mill race to form a base for the casting of the concrete apron.

4.4.5 As part of the construction of the southern wall of the turbine chamber, wall 6 was reduced in height, possibly to allow the installation of shuttering for the mid-floor of the turbine chamber. This material was later used to backfill the gap between the island and the side wall. It would appear that at least part of the drive wheel that was being replaced was sawn into manageable pieces and discarded as part of this filling material.

Appendix A. Archaeological Context Inventory

Context	Type	Depth	Width	Length	Comments	Finds	Date
1	Layer	0.52m	-	-	Made ground under 1922 head race	Brick, tile, nails	C20th
2	Structure	0.15m	5.5m	5.5m	Concrete floor of head race throat running up to sluice gates	-	C20th
3	Structure	0.8m	5.5m	-	Wooden revetment dividing head and tail races for the 1922 turbine installation	Worked timber	C20th
4	Structure	2.6m	0.3m	7.2m	1922 turbine chamber, concrete walls and floor	-	C20th
5	Structure	1.5m	0.9m	5m	Later concrete revetting added to northern side of tail race channel	-	C20th
6	Wall	0.6m	0.5m	5m	Brick tail race wall, hidden behind the 1922 turbine chamber	Brick	Late C18th
7	Wall	> 2m	0.5m	11m	Brick wall/revetting betwee the island and the head race	Brick	Late C18th
8	Layer	> 0.5m	-	-	Made ground	-	-
9	Layer	> 0.5m	-	-	Dredged material from eastern side of the Island	Brick, iron	C19th-20th
10	Layer	Up to 2m	> 5m	20m	Modern made ground	Brick, pottery, glass, iron objects	C20th
11	Layer	0.25m	5m	7m	Topsoil and turf accumulation	-	C20th
12	Layer	1.2m	4m	> 11m	Made ground probably associated with granary	Brick, tile	C18th-19th
13	Layer	1.4m	4m	9m	Made ground possible support for island hurst frame	Brick	C17th
14	Layer	0.8m	4m	7m	Made ground, probably associated with 1626 rebuild	Brick, tile	C17th

15	Layer	> 1.6m	4m	4.8m	Made ground, backfill between wall 6 and island	Brick, tile	Late C18th
16	Layer	> 0.6m	-	-	Possible underlying natural, possibly part of old historic river bed	-	-
19	Structure	1.1m	0.3m	> 0.6m	Line of wooden stakes/piles retaining layer 14	Wood	-
20	Structure	1.1m	0.3m	2m	Wooden revetment of iron pointed stakes retaining eastern edge of layer 15	Wood	C19th
21	Structure	1.2m	0.15m	4m	Remnants of a possible coffer dam built across end of tail race during the 1922 turbine installation	Wood	C20th
30	Fill	> 2m	> 1m	11m	Backfill between the 1922 concrete turbine chamber and the island	Glass, iron, wood	C20th

APPENDIX B. WOODEN ARTEFACT INVENTORY

Number	Type	Length	Width	Depth	Comments	Date
100	Pile	3.4m	0.224m	0.218m	Square iron shod pile, circular sawn	C20th
101	Pile	0.7m	0.177m	0.168m	Oak Iron shod pile	-
102	Pile	1.58m	0.245m	0.218m	Roughly trimmed, axe marks on poit	-
103	Pile	1.45m	0.224m	0.218m	Oak, Square iron shod pile, circular sawn	C20th
104	Pile	0.42m	0.225m	0.22m	Oak, squared, circular saw marks	C20th
105	Beam	1.65m	0.335m	0.28m	Part of a large oak beam, adze hewn with 2 large halfing joints	
106	Beam	1.37m	0.315m	0.22m	Part of a adze or axe hewn beam. 2 halfing joints	
107	Pile	1.68m	0.22m	0.22m	Iron shod square pile	C20th
108	Pile	1.39m	0.22m	0.22m	Round pile, halfing joint on end	
109	Beam	1.48m	0.333m	0.328m	Length of square oak beam, 3 distinct halfing joints	
110	Pile	1.5m	0.22m	0.22m	Square oak iron shod pile, circular sawn	C20th
111	Beam	1.98m	0.358m	0.318m	Lower sill beam for turbine sluice gates (beech)	C20th
112	Beam	1.76m	0.34m	0.2m	Upper sill beam for turbine sluice gates	C20th
113	Pile	0.8m	0.18m	0.16m	Truncated end of a square pile	C19th
114	Beam	1.15m	0.3m	0.2m	Length of re-used oak beam	C18th
115	Beam	1.43m	0.28m	0.2m	Length of beam, many nail/spike holes, possible length of whaler	
116	Pile	0.68m	0.118m	0.1m	Truncated end of a post/pile	
117	Pile	0.6m	0.225m	0.175m	Truncated end of a post/pile	
118	Pile	0.99m	0.244m	0.078m	Wooden planking/sheet pile, part of (21)	C20th
119	Pile	1.95m	0.195m	0.076m	Iron shod planking/sheet pile, beech, circular saw marks, part of (21)	C20th
120	Pile	1.27m	0.238m	0.078m	Iron shod planking/sheet pile, beech, circular saw marks, part of (21)	C20th
121	Post	1.69m	0.23m	0.23m	Iron shod oak post, peeled pole	C18th
122	Post	4.48m	0.27m	0.27m	Iron shod oak pile, roughly adzed square	C18th
123	Pile	0.78m	0.21m	0.07m	Wooden planking/sheet pile, beech, circular saw marks, part of (21)	C20th

Number	Type	Length	Width	Depth	Comments	Date
124	Pile	0.98m	0.21m	0.07m	Wooden planking/sheet pile, beech, circular saw marks, part of (21)	C20th
125	Pile	1.98m	0.25m	0.25m	Round post, square point, beech, formed corner between tailrace and island revetting	
126	Post	1.25m	0.22m	0.22m	Short length of round post supporting wall (6)	C18th
127	Post	1.45m	0.245m	0.245m	Short length of round post supporting wall (6)	C18th
128	Post	1.46m	0.18m	0.18m	Short length of round post supporting wall (6)	C18th
129	Pile	0.94m	0.22m	0.075m	Iron shod planking/sheet pile, beech, part of (3)	C20th
130	Pile	1.2m	0.22m	0.075m	Iron shod planking/sheet pile, beech, part of (3)	C20th
131	Pile	0.94m	0.22m	0.075m	Wooden planking/sheet pile, beech, part of (3)	C20th
132	Pile	0.91m	0.24m	0.073m	Wooden planking/sheet pile, beech, part of (3)	C20th
133	Pile	0.88m	0.2m	0.078m	Iron shod planking/sheet pile, beech, part of (3)	C20th
134	Pile	0.55m	0.2m	0.078m	Iron shod planking/sheet pile, beech, part of (3)	C20th
135	Beam	2.27m	0.227m	0.219m	Whaler/beam nailed to line of wooden sheet piles, part of (3)	C20th
136	Beam	1.3m	0.32m	0.165m	Truncated length of beam, mortise and halfing joints	
137	Beam	1.43m	0.24m	0.24m	Length of beam, two halfing and a dovetail joint	C14th
138	Beam	1.25m	0.5m	0.42m	Truncated length of oak beam reused as whaler. Four mortise joints	
139	Post	1.96m	0.12m	0.12m	Round beech post nailed spiked to (138). Part of island revetting	
140	Start (spoke)	0.82m	0.095m	0.065m	Oak start or spoke from earlier waterwheel, 5 dowel holes	
141	Post	2.1m	0.22m	0.22m	Vertical post protecting corner of brickwork at throat of northern head race	C18th
142	Beam	2. 8m	0.16m	0.1m	Wooden beam or whaler retaining wooden planked revetting, part of possible jetty	C18th
143	Pile	2.36m	0.22m	0.2m	Vertical square pile retaining whaler (142) and planked revetting	C18th

Number	Type	Length	Width	Depth	Comments	Date
144	Start (spoke)	0.87m	0.097m	0.065m	Oak start or spoke from earlier waterwheel, 5 dowel holes	
145	Start	0.2m	0.065m	0.003m	Truncated tenon from end of start or spoke from earlier waterwheel, 2 dowel holes	
146	Start	0.18m	0.065m	0.025m	Truncated tenon from end of start or spoke from earlier waterwheel, 2 dowel holes	

Appendix C. Bibliography and References

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APPENDIX D. SUMMARY OF SITE DETAILS

Site name:	New Low Head Turbine Installation, Mapledurham Watermill, South Oxfordshire
Site code:	MADWAT 11
Grid reference:	NGR SU 6693 7674
Type of watching brief:	Watching brief on the dismantling of structures associated with a 1922 turbine installation and excavation of new foundations and channel for a modern turbine.
Date and duration of project:	May-August 2011
Area of site:	*c* 800 m^2
Summary of results:	The watching brief observed details of the 1922 turbine installation, and several phases of mill race construction associated with the 18th and 19th century expansion of the mill. No *in situ* evidence was encountered for mill races or structures pre-dating the 18th century mill. Elements from previous phases of the mill's construction were recovered from ground raising dumps that had been used to raise the ground level on the island to the south of the mill during the remodelling of the southern mill race channel. This included fragments of a waterwheel, including wooden parts and iron fittings, probably from the wheel that was removed in 1922.
Location of archive:	Oxfordshire County Museum Service under accession number OXCMS:2011.26

Figure 1: Site location

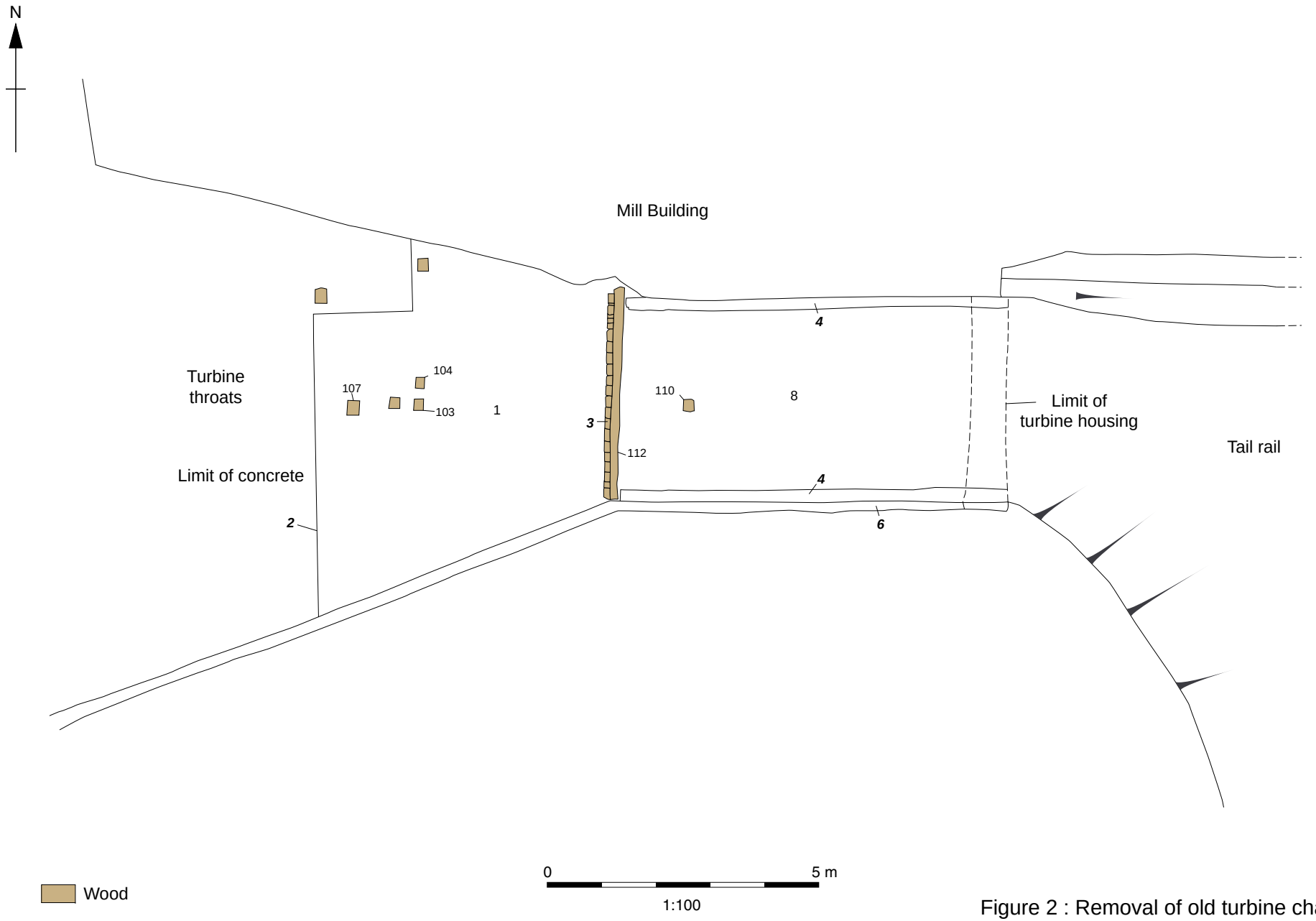


Figure 2 : Removal of old turbine chamber

Figure 3 : Lowering and widening of millrace channel

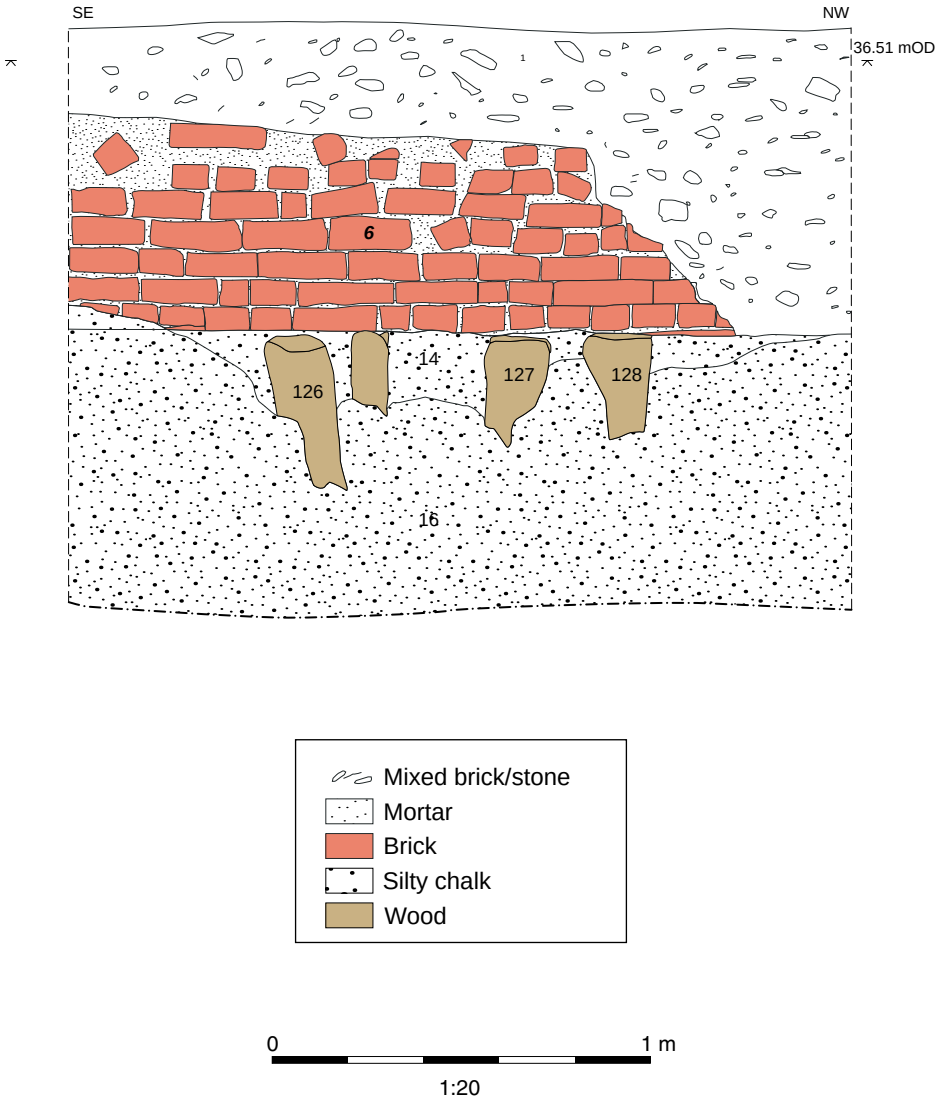
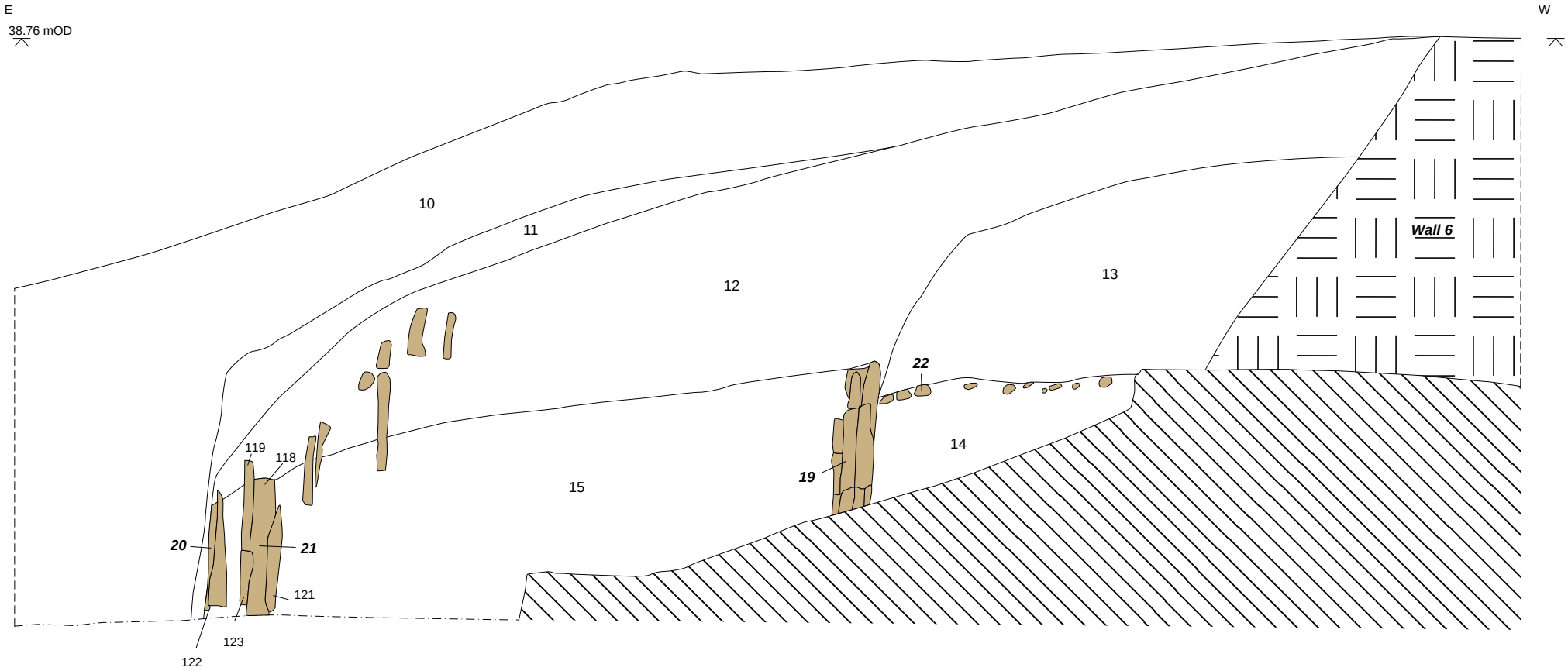


Figure 4 : Elevation of wall 6

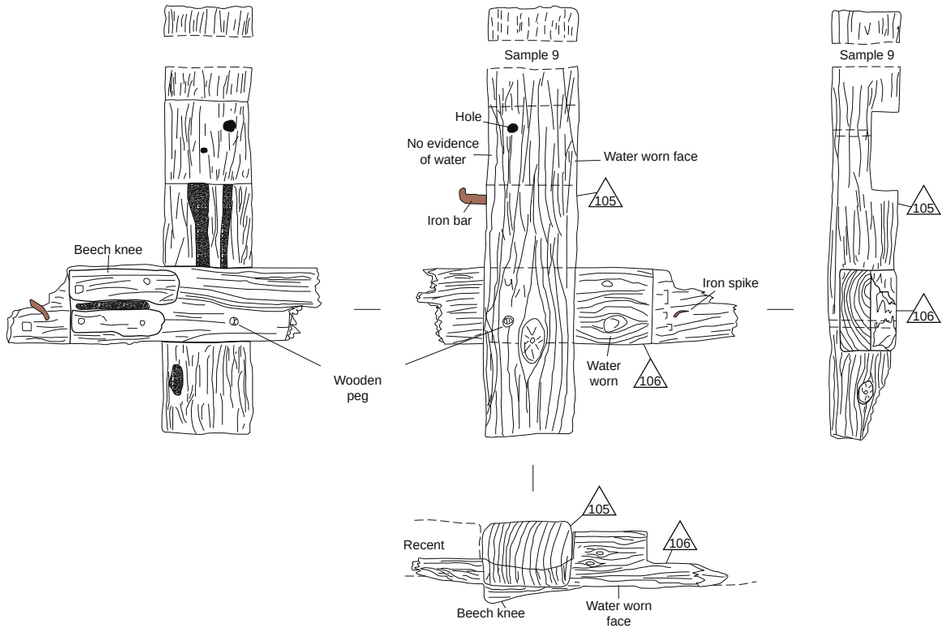


Wall (in situ)
Concrete
Wood

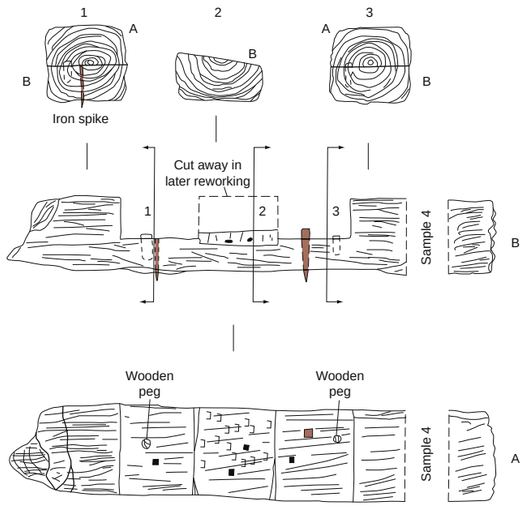
0 2 m

1:50

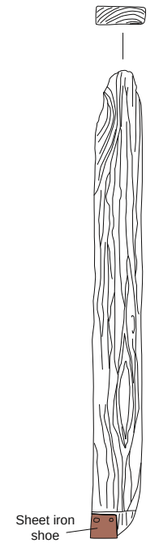
Figure 5 : Section 1



Timbers 105 and 106



Timber 109



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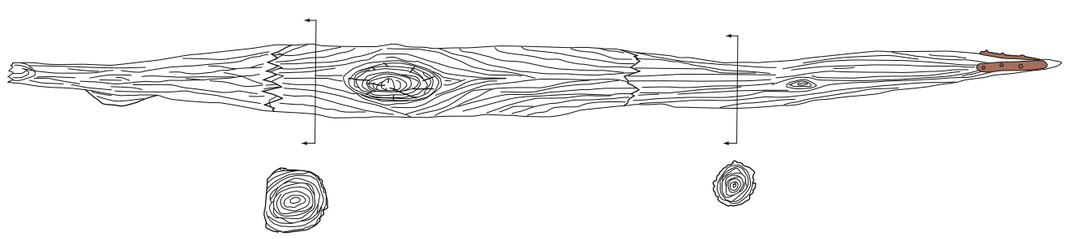

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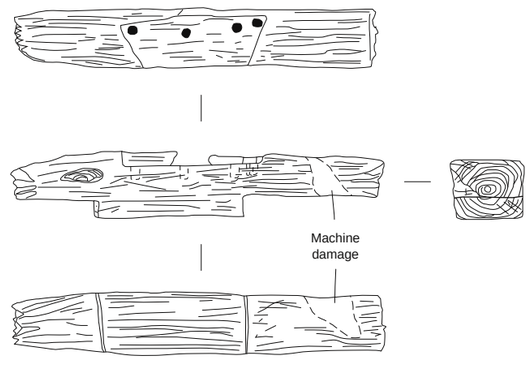
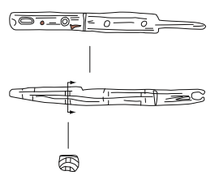
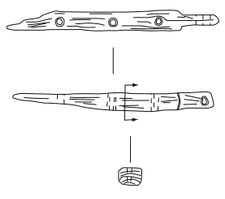


Timber 137



Timber 140



Timber 144

Iron
Bitumen
Hole (not completely bored)
Chisel marks

0 1 m

1:25

Figure 6 : Worked timbers

Plate 1: South-east elevation of Mapledurham Mill, with the southern turbine chamber and mill race to the left

Plate 2: The temporary coffer dam and access road viewed from the west, with the mill to the rear

Plate 3: North-east end of structure 3

Plate 4: Southern mill rail following demolition of 1922 turbine

Plate 5: Revetting in the northern mill rail

Plate 6: Piles supporting wall 6

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