Combe Mill

Overhaul of Waterwheel – 2008/2011

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Introduction

This document tells the tale of the work done on the Combe Mill waterwheel from 2008 to the present time.

Past History

Before 2008 members of the Society had run the waterwheel by pumping water from the tail race but a member was always on hand with a sledge hammer to knock back the various wedges that worked loose.

In 2004 members had dug out the remains of the head race, discovered the steps leading down into it, and installed oak piling to hold back the enlarged head pond.

In November 2004 David Brown replaced the teeth of the pit wheel with hornbeam wood.

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Symptoms

For many years the waterwheel would only turn for a while before one of other wooden wedge needed hammering home. Either one of the gudgeons would work loose and cause misalignment or one of the wedges securing the wheel to the wooden shaft would be the problem.

The clearance between the wheel and the adjacent stonework is about 10mm each side and only a slight misalignment can cause it to run aground.

The default operating mode on open days was to have a volunteer on standby with a sledge hammer.

The water supply to the wheel was from a submersible pump in the tail race. Latterly a pipe manifold has been fitted across the front of the wheel so that water entered direct into the buckets. Larger three inch electric pumps were bought and used by the underlying problem was instability of the wedging.

On one steaming day the wedges of the pit wheel became so loose that the pit wheel detached from the main shaft.

The condition of the wheel buckets was that two of them had pieces missing so they did not hold water and the wheel was not in balance.

Possible Causes

It was thought that drying out of the wooden wedges between runs was a principle cause of the problem but it became apparent that the wedging was piecemeal and was not providing an event grip across the faces of the octagonal wooden axle.

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Work done

July 2008 The pit wheel came loose from the axle when wedges fell out. New member Nicholas Washington has fitted a three inch pipe manifold with four off-take valves across and above the leading buckets. The valves can be adjusted to even out the water flow across the width of the waterwheel.

Water manifold feeding direct into buckets

Aug 2008 Nicholas Washington with the help of Ron Winfield and his hydraulic jack, re-fixed the pit wheel and obtained a three inch electric pump to take water from the tail race into a pipe manifold fitted just above the leading bucket pair. The wheel turns but poor wedging means it required constant attention to keep it turning.

Jacking the axle into alignment

Witness marks

June 2009 Bill Keen began to lead efforts to overhaul the waterwheel. First task had been to level the wooden shaft. Oak wedges were cut by Hon Member Joe Curryer. Reported that pump suction filter from tail race was constantly blocking with debris. WODC awarded us a heritage grant towards the work.

July 2009 Several work sessions on Wednesday had taken place to take out the old softwood wedges and replace them with oak. Tony T, Brian L and Bill K all involved.

Ron R used his hydraulic jacks to move the wheel into alignment. Floodlights used to illuminate the working area and noted to show off the wheel very well. Photo of work underway featured in the Oxford Gazette.

Posing for the local newspaper to demonstrate wise use of WODC Grant

A second three inch 'blue' electric pump was purchased.

Sept 2009 Team have completed wedging the waterwheel to the shaft and also the pit wheel to the shaft. Folding wedges have been used to spread the load over the entire surface of the shaft faces. Work is aimed at pumping water into the head pond and over the sluice into the buckets without depending on the tail race pump and the pipe manifold.

New folded oak wedges

Oct 2009 Wedging all complete and just the surplus wood needs to be trimmed. A trial using the two electric pumps and the diesel pump (already on loan from Joe Curryer) showed that the wheel would not turn. The trial showed that the water from the wheel is backing up because the tail race has silted up. A digger and driver was hired (Paul Gibson) for a day and the tail race cleared out. For open days water was pumped into the manifold. Another problem noted was that the axle gudgeon on the pit wheel end worked loose during running and posed a serious problem.


Excavating the tail race channel

Nov 2009 Further pumping trials done to find out the flow of water needed to turn the wheel by pumping into the head pond. The tests showed that we needed 500 gallons per minute to get the wheel turning. A decision was taken to find an electric pump capable of 1000 gall per minute to provide plenty of margin.


Early experiments with pump from river to tail race

Jan 2010 A communing companion of member Steve Page works at Thames Water and has sort of offered to get us a large submersible pump. Looking at vendor data against what we then thought we required, it seemed that it would be far too large. The vendor also warned that people only get rid of electric pumps if there is something wrong and that any repair cost would run into thousands of pound. The offer was not pursued.

This month, too, Bill Keen found the Stuart Pump company and what seemed to be a suitable pump.

Feb 2010 A submersible electric pump was bought second hand from Stuart Pumps and delivered to site. Using a hired digger, the pump was lowered into a cut-out in the river bank and a four inch duct was buried between the mill and the river end of the barn engine house to take an electrical cable. After much dithering with various electricians, Southern Electric Contractors quoted for the installation and the correctly rated motor starter. Society funds did not cover the cost and a delay looked inevitable. Joe Curryer took away his diesel water pump.

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Submersible pump on arrival

Digger driver lifts Joe Curryer's diesel pump out of the way

Submersible is lifted into position in a recess in the river bank

Mar 2010 Water was pumped from the tail race into the manifold for open day but the wheel was stopped when a spare wedge fell into the pit wheel sump and jammed rotation – no damage was caused.

At some stage it was thought that maintaining a degree of resistance to the water leaving the wheel might build up a level in the wheel pit and retain more water inside the buckets. The theory was later proved wrong when flow rate was increased.

Board across tail race to retain water under the wheel

Bill Keen and Brian Layt found that although the wheel could turn it 'ran aground' every revolution and had to be kick started.

Apr 2010 The loose gudgeon in the gear room was removed and refitted.

The binding rings were removed and refitted using hydraulic jacks. The original wedges – probably fitted in the 1980s – were found to be mostly

polished mahogany and much was rotted. Tony T arranged for new oak was purchased from and cut to shape by Eynsham Sawmills. Metal spacers were also used to make up gaps where the axle shaft timber had rotted. Finally a metal end plate was screwed to the axle shaft to stop wedges from working out. The wheel now rotates much more reliably.

Iron hoops removed

Henry Sparrowhawk and Ron Winfield examine the gudgeon retaining wedges

Winged gudgeon

Shaft end showing wear

Pressing the gudgeon and new wedges into place

Metal disc screwed to end of shaft to retain wedges

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May 2010 For open days the wheel was fed via the pipe manifold with water from the tail race using one of the three inch 'blue' electric pumps which self primes. The wheel just about turns but could not power anything.

A further pumping test was done this month using a borrowed Sykes motor driven pump.

Jack Swallow's Lister driven pump lending a hand one steaming day

Eventually a generous donation from a visitor now meant that we could afford to have the three-phase electrics installed for the submersible river pump.

Three-phase electrical supply being paid to the end of the 'old' barn engine shed

June 2010 When the cabling was installed, the first trials of the river pump (4 June) resulted in a lot of vibration and cavitation but very disappointing flow rate. It

turned out that the motor had been wired in reverse (9 June) and once corrected the pump gave all it could.

Unfortunately the amount of flow fell drastically short of being enough to turn the wheel. We still needed to pump water from the tail race as make up flow – the flow so produced was estimated at 835 gall/minute (3800litre/min) and the wheel rotates about 1 rev/minute.

Water surges into the head pond from the new submersible

The good news was that the wheel now turned remarkable reliably.

July 2010 Several pumps were hired for a day to discover exactly how much water flow would be needed to turn the wheel. We hired two 900 litre/min diesel pumps and an 800 litre/min submersible. Using our red river pump and the two blue electric pumps, we were able to throw 7,200 litre/min into the head race. The wheel turned at 3.5 rev/minutes.

Diesel pumps hired for the trial made a spectacular difference

Bill Keen made contact with Carter Pumps at New Yatt and later Carlton Tarrant offered to combe to the Mill on an open day to see what is required. It took until November for Philip Hawtin to persuade him to visit.

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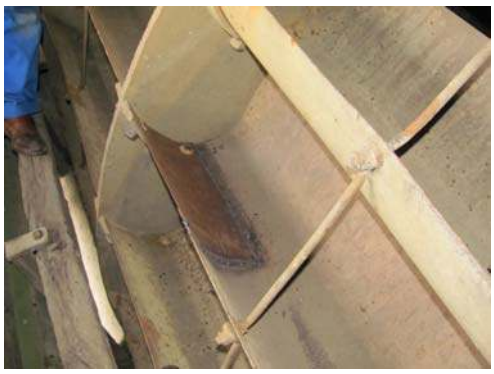
Aug 2010 Ron W obtained some sheet steel and fabricated plates to weld to the two broken waterwheel buckets. Using the red river pump and the blue tail race pump, the wheel turning rate increased from one rev/min to 2½ rev/min once the broken buckets were patched.



Ron Winfield welds a metal plate to repair one of three buckets

Ron Rutherford and Ken Crawford began work on replacing the damaged teeth of the second gear in the train.

Ron Rutherford takes out old teeth while Ken Crawford measures up for the new

Tony Simmons attempts to broker a deal with Stuart Pumps to change it for a more powerful one. Having been sent a sketch of the pump installation, Stuart Sayer explained that we had not considered the characteristics of pumps and not accounted for the head loss arising from pipe runs and bends. He also explained that the pump must run fully submerged not only to deliver the

nameplate flow but also to keep the electric motor cooled. He is unprepared to accept that the pump is not what we specified.

Sep 2010 The wheel continues to behave and turns steadily at 2½ rev/min. The damaged second gear teeth had now been replaced. However, the river level had been too low to allow the red river pump to be used. Pipe (10in dia.) has been bought to lay for another route for a future second river pump

10" pipe awaits laying but was later exchanged for a smaller diameter

A good level in the head race needed to turn the wheel – we found that it was more flow that was really required

Oct 2010 The newsletter reported that the used of the red and one blue pump was providing a good demonstration of the wheel at about 2 rev/min for visitors.

When the river level is up, the red pump alone will turn the wheel but it needs help to start turning. The blue pump from the tail race is needed to guarantee self starting. The wheel is now being run for visitors on Wednesdays and Sundays as well as teaming events. Plans are being discussed to get the final spur gear up onto the stub shaft ready for it to be engaged with the line shafting. The gear room has been cleared out in readiness.

Nov 2010 Carter Pumps visit and tell us that submersible pumps are twice as expensive as surface mounted ones – Carlton Tarrant promises to quote us for a good deal.

Jan 2011 Discussions were held to plan next steps in the project. Attempts to engage with Stuart pumps achieved nothing despite the fact that Mr Stuart Sayer had promised his help.

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Quotation from Carter Pumps is received and is about £10K. Carlton Tarrant is now saying that electric pumps rarely come onto the second hand market.

Feb 2011 Bill Keen is put in touch with Sykes Pumps based in Reading. Sales Engineer Steve Covell visits the Mill and departs promising to quote for a hire pump. He reckons that submersibles are cheaper than surface pumps.

Mar 2011 We are waiting to hear from Syke pumps.
We are seeking to get a pump capable of 1,500 – 2,000 gpm.
Our open season begins as it ended in October 2010.

The story continues ……

Person(s) involved: Bill Keen, Ron Winfield, Henry Sparrowhawk, Tony Thurlby, Brian Layt, Joe Curryer, Tony Simmons, Nicholas Washington, Ron Rutherford, Ken Crawford.

Written by: Tony Simmons

10 March 2011