Desk-based assessment of certain weirs on the River Severn in Gloucestershire and Worcestershire

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Introduction

General

A desk-based assessment of certain weirs on the River Severn in Gloucestershire and Worcestershire (Upper Lode, SO 882 328, Diglis, SO 846 535, Bevere, SO 837 596, Holt SO 819 634, and Lincomb, SO 819 695; Fig 1) was carried out at the request of David Viner of the Canal & River Trust. This work was undertaken in order to inform a project to install fish passes on these weirs. The weirs were initially completed between 30th December 1843 (Lincomb) and 10th August 1858 (Upper Lode) by the Severn Commissioners.

The desk-base assessment comprised documentary research at the Gloucestershire and Worcestershire Record Offices. It was found, unsurprisingly, that many documents at the Worcester record office were duplicated at Gloucester. However, certain documents at Gloucester threw light on the process of obtaining consent for the construction of the weirs. The archives at the Institute of Civil Engineers were closed for refurbishment until March 2017 so this source was unable to be consulted. A search for previous archaeological work on the Severn weirs was made on the Heritage Gateway.

Limitations of documentary research

Practical limitations on the efficacy of documentary research have recently been commented upon by Buffery (2015; 97). With specific reference to the Gloucestershire Archives she said:

...once at the archives, visitors may only order three documents at a time, and each 'run' leaves on the hour until the hour before closing [currently there is a single 'run' per day, leaving at noon]. Inevitably, as the online catalogue does not give you an image of the potential document, from the maximum of 21 documents that I could view per day, many would be unusable, some were unreadable, and others were documents that I already had knowledge of. Once a useable document is found, photocopying is out of the question for many of the more delicate items, and so the process of copying (in pencil) the record begins.

The Gloucestershire Archives represent an extreme case of an arcane system, entirely unsuited to modern research needs, yet further restricted by financial cut-backs. However, similar comments could be made with regard to any of the other county-based archive services.

Summary

A desk-based assessment of certain weirs on the River Severn in Gloucestershire and Worcestershire was carried out on behalf of the Canal & River Trust. This was done in order to better understand the structures prior to fish passes being installed.

It was found that the first to be built was Lincomb lock and weir (completed on the 30th December 1843). Thereafter, the weir at Holt was completed on the 19th June 1844, and and those at Bevere and Diglis were completed simultaneously on the 19th October 1844. The lock and weir at Upper Lode was completed on 10th August 1858.

Comparisons were made with Powick weir on the River Teme, a tributary of the Severn. This was the only nearby weir that had been archaeologically recorded.

Documentary references make it clear that fish passes were present on Bevere, Holt and Lincomb weirs in 1885-1887, although their configuration did not comply with current legislation and they had to be altered.

The documentary material

Historic mapping

The earliest available and relevant maps were made in the mid 1840s to late 1850s to show the proposed weirs and locks at the various sites (Figs 2.1, pre 1844; Fig 2.5, pre 1844; Fig 2.10, pre 1844; Fig 2.14, pre 1843; Fig 2.17, pre 1858). These maps show a 'line of deviation'. This was a device employed in a Parliamentary Act to enable minor changes to be made in the position or alignment of the works, should circumstances require this, without having to reapply to Parliament for a further Act. Subsequent to these maps, the usual run of early Ordnance Survey maps (mid 1880s, and early to mid 1900s were available). There was a further series of maps (Fig 2.21) in a report by Rendel, Palmer and Tritton (1947) which proposed changes to the configuration of the locks and weirs. This scheme was never implemented but the maps are included for completeness.

At Bevere Island (Fig 2.1) the pre 1844 map shows proposals for a lock at the southern end of the west channel and a weir (dam) at the northern end of the east channel. The weir is shown diagonally across (ie not perpendicular to) the east channel. The Ordnance Survey map of 1886 (Fig 2.2) shows that Bevere Island was not used in the creation of the lock and weir. Instead an artificial island appears to have been created to the south of Bevere Island, with the lock being constructed adjacent to the west bank of the river and the diagonal weir running between the artificial island and the east bank. The Ordnance Survey maps of 1928 and 1940 (Figs 2.3 and 2.4) show no significant differences.

At Diglis (Fig 2.5) the pre 1844 map shows proposals for a diagonal weir in a bend of the original channel of the river with a new cut being made for the lock to the south. An additional proposed cut is shown immediately to the south of this new cut to provide a double lock in order to address the issue of delay to traffic raised by the Birmingham Canal Company (Appendix 2, document 3, and below). The Ordnance Survey map of 1886 (Fig 2.6) shows the double lock and weir in comparable positions to those shown on the pre 1844 map. The Ordnance Survey maps of 1904, 1928 and 1940 (Figs 2.7, 2.8 and 2.9) show no significant differences.

At Holt (Fig 2.10) the pre 1844 map again shows proposals for a diagonal weir in a bend of the original channel of the river with a new cut being made for the lock to the north. The lock is situated at the eastern end of the new cut with the diagonal weir located near the apex of the bend. The Ordnance Survey map of 1884 (Fig 2.11) shows the lock situated at the eastern end of the new cut, although perhaps a little further west than shown on the pre 1844 map. The weir is shown diagonally in the original channel of the river but it more nearly perpendicular that shown on the pre 1844 map. The Ordnance Survey maps of 1903 and 1927 (Figs 2.3 and 2.4) show no significant differences.

At Lincomb (Fig 2.14) the pre 1843 map shows proposals for a lock in a bend of the original channel of the river with a new cut being made for a diagonal weir to the west. The weir being located near the northern end of this new cut. It is difficult to be certain from the map evidence alone but it appears from the Ordnance Survey map of 1884 (Fig 2.15) that the new cut was made for the weir, more or less, in the position anticipated on the pre 1843 map and that the weir was similarly so constructed. However, at least the eastern part of the original river channel was by-passed (perhaps to avoid a small stream entering the river immediately above the lock), the lock itself being built against the former west bank of the river. If this is so, the tongue of land forming the new east bank of the river, and against which the eastern side of the lock is built, may be wholly artificial. The Ordnance Survey map of 1927 (Fig 2.16) shows that the former eastern river channel has completely silted-up, the small stream now petering out in a marsh.

At Upper Lode (Fig 2.17) the pre 1858 map shows no proposals for a lock or weir. The Ordnance Survey map of 1886 (Fig 2.18) shows that the original channel of the river has been completely by-passed with a new cut being made to the south-east for both the lock and weir channels. The weir is a diagonal example, as on the previous examples. The Ordnance Survey maps of 1902 and 1921 (Figs 2.19 and 2.20) show no significant differences other than the gradual silting of the former river channel.

Summaries of historic documents and contemporary engineering directly relevant to the Severn weirs (date order)

The first proposals to improve the condition of the Severn for navigation were made in 1784 when William Jessop made recommendations for *improving the navigation of the Severn from Meadow Wharf in Coalbrookdale to the deep water at Diglis below the city of Worcester*. He recommended that four locks with four dams or weirs should be erected at:

- Diglis
- Barbourne Shoal
- Holt
- Larford (Lincomb)

Strenuously opposed by a variety of interests, this plan fell through.

The Staffordshire and Worcestershire Canal Company, under the powers of the Act of 1790, erected timber-framed jetties filled with stones, projecting from the shore so as to contract the stream at the head of the shoals and by thus increasing its velocity to enable it to wash away the gravel which occasioned these shoals. These jetties did not find favour with the bargemen and others navigating the river. They were ultimately indicted as a nuisance and at the Worcester Assizes held in March 1793 they were held to be so and were removed.

No further attempt to improve the river was made until 1835 when a railway, being proposed from Gloucester to Birmingham, avoiding Worcester, the importance of a more perfect water communication was again discussed.

The Bill was strongly opposed by the Gloucestershire and Shropshire interests and by the Gloucester and Berkeley and Worcester and Birmingham Canal Companies and was rejected by Parliament on April 12th 1837.

In 1838 a modified proposal, intended to conciliate its opponents, was submitted to Parliament, together with a rival scheme promoted by the Worcester and Birmingham Canal Company and by which it was proposed to make the Severn navigable from Gloucester to Worcester at all times by vessels drawing five feet of water. Neither of these Bills was carried to a second reading as negotiations between the two contending parties were underway in the hope of procuring an improved navigation.

Negotiations over the following three years resulted, in 1841, in a Bill being introduced. After much opposition and modification this was given the Royal assent and became known as *The Severn Navigation Act 1842*. The Commissioners appointed to carry the Act into execution comprised a body of eighty gentlemen representing various interests in connection with the Severn. This body was afterwards incorporated by *The Severn Navigation Act 1869* under the name of *The Severn Commissioners* is practically the same as at present [1892].

The modifications which were made to the Bill during its passage through Parliament were:

- the Commissioners were only authorised to canalize the river by means of upholding weirs and locks to be erected between Stourport and Worcestershire
- they had to depend upon dredging alone for deepening and otherwise maintaining the proposed depth in the channel between Worcester and Gloucestershire
- the lock and weir to be erected at Lincomb should be in operation for three clear months before a second lock and weir were permitted and that one of those months should be a January

The question of changes to the navigation regime of the River Severn became a vexed and controversial one. The advocates of the improvements collected factual information to support their case. This took various forms but included a list of thirty-five boats (Severn trows) lost at various locations on the river between 1810 and 1841 (Appendix 1, document 1) and the number of days that there was less than 3 feet and less than 4 feet of water over the Ketch Shoal near Worcester and Redstone Rock near Stourport between 1836 and 1838 (Appendix 1, documents 4 and 5). Detailed comparisons (Appendix 1, documents 2 and 3) were also made between the existing costs of

transporting a certain quantity of goods (the need for a larger number of more lightly laden vessels) and what the costs might be with a greater depth of water (fewer, more heavily laden vessels).

Estimates were obtained for the execution of different schemes for the improvement of the river (Appendix 2, documents 1 and 2) and detailed explanations made for the location of locks and weirs in one place rather than another (Appendix 2, document 3).

This approach was entirely in keeping with the *zeitgeist* which Dickens (1854) satirised in Hard Times:

NOW, what I want is, Facts. Teach these boys and girls nothing but Facts. Facts alone are wanted in life. Plant nothing else, and root out everything else. You can only form the minds of reasoning animals upon Facts: nothing else will ever be of any service to them. This is the principle on which I bring up my own children, and this is the principle on which I bring up these children. Stick to Facts, sir!

By contrast, the pleas of the opponents of the improvements to the navigation followed a common, rather plaintive tone. A single example will suffice:

Petition of the owners and occupiers of land against the proposals 1836 That the works will raise the level of water in the river and that this will be:

- injurious to the drainage of the adjacent lands
- that the imposition of tolls will reduce the value of these lands
- that the powers of the navigation company will be otherwise detrimental to the interests of the adjacent land owners and occupiers.

Report to the Lord Commissioners of the Admiralty: Severn Navigation Improvement Commission Bill (Bethune and Vetch 1849)

Bethune and Vetch were appointed to make a local inquiry into the case of the Severn Navigation Bill, then before Parliament.

They began by noting that the engineers seemed to have made no allowance for the effect of a tapering estuary upon flood tide levels nor to have considered the effects of their scheme upon the whole of the river from the estuary upwards. Nevertheless, the engineers had no qualms about constructing weirs across the river and were only starting to collect tidal observations.

Bethune and Vetch considered that the navigation could be naturally divided into two parts:

- the tidal portion from the mouth near Chissel Point to Worcester (65.5 miles)
- from Worcester to Welshpool (93 miles)

However, since the construction of recent works by the Severn Commissioners it could now be divided into three:

- the tidal portion from Chissel Point to Diglis through the Maismore Channel (65.5 miles)
- the artificial or lockage navigation from Diglis to Gladder Brook (believed to be Dowles Brook about 1km north of Bewdley Bridge; 16.25 miles)
- upland river navigation from Gladder Brook to Welshpool (76.75 miles)

Bethune and Vetch considered that the tidal portion should be improved sequentially from the mouth, upstream and that the configuration and condition of the channel, its geology and its tides should be fully understood before any works were begun. They further considered that it might be premature for proposals for the river's improvement to be brought before Parliament before such information was available.

They declared themselves to highly pleased with the Berkeley Canal and the facilities it offered, leaving the river free of any impediment of weirs and locks for the many small craft that used it. From the opening of the Berkeley Canal in 1827 until 1835, no new works connected with the

navigation of the Severn were contemplated. It was then that gentlemen connected with Worcester proposed a 12 foot navigation from Gloucester to Worcester, capable of accommodating vessels up to 300 tons burden. This was to be achieved by transforming the river itself with locks and weirs between Gloucester and Stourport, to be situated at:

- Alney Island
- Clevelode
- Hawford
- Linchford
- Suncombe Hill

Bethune and Vetch felt that no adequate investigation had been carried out regarding the best way of achieving the improvement of the Severn. They considered that the tidal portions could best be improved by narrowing, straightening and therefore deepening the natural channel between Aust Head and Gloucester. At Gloucester it was felt that the best advantage could be obtained by removing the division of the river and forming a single channel.

The final improvement of consequence up to Diglis Weir was the removal of the old stone bridge at Upton and its replacement with a light timber bridge with an opening span.

They felt that these improvements would produce superior results to placing solid weirs or dams across the river below Diglis, the advocates of which wish to carry them down as far as Gloucester. Having dealt with the tidal part of the Severn, they then went on to consider the artificial length from Diglis to Lincomb, constructed since 1842. They felt that to be concentrating the descent of the river between the upper and lower weirs a condition prejudicial to the general flow and discharge of the water had been created. While it is possible to improve the velocity and therefore the scour of the river between the weirs, this is only at the cost of the loss of velocity and scouring power on the lengths of river above and below the length defined by the weirs. This results in the increased deposition of material and creation of shoals in these areas resulting in greater dredging needs. Evidence for this came in 1847 when the river below Diglis was so impeded with shoals that the navigable depth was reduced from an intended 6 feet (1.83m) to only 2 feet 8 inches (0.81m), notwithstanding that a sum of £2000 had been expended on dredging between Diglis and Tewkesbury that same year. However, in 1848 no money was expended in dredging and yet the depth of water remained adequate all summer for the craft navigating the river. From this they concluded that, in 1847, the river had not yet reached an equilibrium compatible with its new situation. They further concluded that the proposed construction of a weir at Tewkesbury was premature, given that the experience of 1848 suggested that there might be no need for it. Indeed, such construction might exacerbate the creation of shoals.

They considered that the benefits of canalizing the river outweighed the difficulties but concluded that it would have been better to have constructed a canal from Worcester to Stourport, rather than dams in the bed of the river. Similarly they concluded that if it was necessary to continue the lockage below Diglis, it should be by canal rather than by locking off a length of the river which currently benefits from the tides.

They noted that the proposed lockage on the Severn is little more than a prolongation of the several navigations which currently leave from it and the works seem to have been laid out with that circumstance in view. The beneficiaries are the Staffordshire Canal (Lincomb Weir), The Birmingham Canal (Diglis Weir), the Avon Canal (the proposed weir at Tewkesbury) and the Berkeley and the Hereford Canals (the weirs near Gloucester). This would appropriate the River Severn as a grand trunk to the canal navigations. The principal carriers on the Severn were of the opinion that the proposals would not be successful and the result would be to advantage the railway.

They noted that the works below Diglis had been carried out without the knowledge or consent of the Lords Commissioners of the Admiralty, required on works below high water level. Had this been sought it would have resulted in terms and conditions that would have produced a 6 foot navigable channel and avoided the expense of bringing in Bills in 1848 and 1849 to place a weir at Tewkesbury, in addition to the costs of construction. The Severn Commissioners disputed the jurisdiction of the Admiralty.

The construction of Lincomb lock and weir was commenced on 28th June 1843 and completed on the 30th December. The three months having expired and no damage having been sustained by the works, the construction of the other locks and weirs was proceeded with, the weir at Holt being completed on 19th June 1844 and those at Bevere and Diglis simultaneously on 19th October.

During the period of the construction of the locks, and weirs and for a period of two years thereafter, the Severn Commissioners dredged the fords and shoals below Worcester was proceeded with but it became apparent that for want of upholding locks and weirs between Worcester and Gloucester, these operations appeared to be interminable for although six feet of water was obtained below Diglis by the employment of four powerful dredgers, it became evident that such depth could not be maintained for a month after the dredgers ceased to work.

In 1847 the Commissioners determined to apply to Parliament for further powers to construct a lock and weir in the vicinity of Tewkesbury. The Admiralty reported against this proposed extension of the canalization of the river (Bethune and Vetch 1849) and the Bill was rejected on its second reading. The Bill was resubmitted in 1848 and was again thrown out at its second reading in 1849. In 1852 the Commissioners made a third application to Parliament to construct a lock and weir at Upper Lode near Tewkesbury and this Bill received the Royal assent on 14th June 1853. Work commenced in autumn 1856 and was completed on 10th August 1858.

These difficulties became more and more pressing and further applications were made to Parliament to construct weirs and locks at Maisemore and Llanthony. This received Royal assent in July 1869 and the works were completed in 1871, thus completing the canalization between Stourport and Gloucester.

Changing landscapes: a legal geography of the River Severn (Buffery 2015; 127)

The first Salmon Fisheries Act was passed in 1861, a major piece of legislation with thirty-nine clauses which repealed almost all previous legislation on the matter. It placed the superintendence of the salmon fisheries in the Home Office, prevented pollution, fishing by use of lights, spears 'gaff, strokehall, snatch, or other like instrument' and the use of roe as bait. Nets were regulated to two inches knot-to-knot; fixed engines were banned, with penalties for the taking of unclean fish and young salmon. It also compelled those with artificial channels (i.e. canal companies and fisheries) and any licensed fishery to attach a 'fish pass' and to put up and maintain gratings across the races to stop the salmon descending into locked waters. The closed season was between September 1st and February 1st with an additional close time between noon Saturday and six on Monday morning. During this period, the proprietor or occupier of every fishery was to maintain a clear opening of 'not less than four feet in width from the bottom to the top' through all cribs, boxes, or cruives so that a free space was secured for the passage of fish up and down through each. This is the legislation referred to in the document below, with which the Severn weirs had to be made to comply.

In the matter of stopping up unnecessary fish passes in the Severn navigation weirs (Southall 1885-1887)

The whole of this document has been transcribed as Appendix 3. The most significant statements have been extracted below.

July 18th 1885

Instructions to apply to the Conservators of the Severn Fishery District to enter into an agreement under Section 23 of the Severn Navigation Act 1881 for the stopping up and removal of the fish passes in some of the Severn Navigation Weirs which had become unnecessary owning to the existence of a more perfect fish pass in each of such weirs.

October 8th 1885

Attending meeting of the Conservators when the Chairman reported the position of the matter, and he was authorised to make an arrangement with you for the temporary stopping up of some of the passes in one of the weirs and (if necessary in his opinion) for the temporary enlargement of the remaining pass in such weir.

April 20th 1886

Attending Mr Stallard, conferring as to the alterations required by the Act to be made in the passes that would remain, when he wished measurements to be made of the apertures of the existing passes and arranging to request Mr Marten to arrange for this to be done.

October 1st 1886

Letter to Mr Stallard therewith, and that the Conservators had now to determine whether they would have the openings in the passes that are to remain lengthened or deepened or a combination of both of those alterations.

April 13th 1887

Attending Mr Marten and with him on Mr Stallard conferring on the proposed inspection and on the means of altering the remaining fish passes in Bevere weir to comply with the provisions of the Act.

June 10th 1887

Letter to Mr Stallard informing him (in reply to one from him) that the 'Dawn' should be at Worcester Bridge at 10.15 on the 13 instant.

June 13th 1887

Journey up the river with Mr Bund, Mr Stallard and Mr Marten again inspecting the fish passes and arranging the alterations to be made in those which were to remain and journey home.

June 18th 1887

Attending meeting of the Committee...when a resolution was passed...and instructions were given to the Engineer to carry out the alterations of the fish passes and also some alterations of the aprons of the weirs at Holt and at Lincomb required for improving the approach to the fish passes therein.

Water Engineering (1888)

The circumstances of the construction of the Severn weirs was provided by Slagg (1888). Evidence was given before the Select Committee of the House of Lords on Conservancy Boards in 1877 regarding the Severn weirs. When the Severn Navigation Commissioners were before Parliament for authority to construct these weirs the question was fought over for nearly six weeks, and the result was that a form of weir was arrived at which not only penned up a certain quantity [of water] for the purposes of navigation, but facilitated the passing off of the flood water as well. The form arrived at was a solid weir, with a level crest from end to end and without sluices or means of passing off the water other than over its top. The back of the weir is rounded off to a parabolic curve, instead of being, as most weirs of the kind are, flat on the top. This improved form gives greater velocity to the water passing over the weir and reduces its height for any given quantity passing over.

Another design element of the Severn weirs is their considerable length compared to the width of the river. This is another measure to further reduce the height of the water due to any given quantity passing over the weir. By constructing the weir aslant of the river's course (making it, for a river 150 feet wide, eg 500 feet long or thereabouts) and combining this with the previously mentioned parabolic form, an increase in the velocity of the water of 5:7, is obtained, compared to a weir with a flat crest.

Slagg also noted that during high floods boat traffic could pass over the Severn weirs instead of passing through the locks, the weirs being submerged and the water surface nearly level. This is not as unlikely activity as it might sound. It has long been the practice for boats navigating the Thames to pass over Teddington lock at high water instead of passing through the lock.

Report upon the past history, present state and further improvements of the navigation of the River Severn (Marten 1892)

Proposals to canalize the Severn included the construction of a lock and weir near Gloucester in order to produce a depth of water of 9 feet (2.74m) at the cill of the Gloucester and Berkeley Canal and a depth of 14 feet (4.27m) as far as Sandy Point, near Saxon's Lode (*c* 17.5 miles above Gloucester). There, another lock and weir would be built to maintain the water depth at 12 feet (3.7m) as far as Wiseman's Ford, below Camp House (about 3.5 miles above Worcester, in the vicinity of Bevere). Further locks and weirs would be constructed at Wiseman's Ford, at Holt and at

Lincomb to maintain a water depth of 6 feet 6 inches (1.98m) as far as Stourport. The locks were proposed to be 130 feet (39.6m) long and 40 feet (12.19m) wide with the cills set at such a depth as to allow of the river being deepened as required. The cost of this was estimated at £244,503 16s 0d (£244,503.80).

This project was in advance of anything previously proposed or at the time attained. Part of the proposed depth was to be achieved by raising the level of water in the river around 2 feet (0.61m) higher than, owing to opposition from landowners, was allowed by Parliament.

Report No 4 on the improvement of the navigation of the River Severn for 300 ton barges between Upper Parting (near Gloucester) and Stourport (Rendel, Palmer and Tritton 1947)

This comprised a report and plans (Fig 2.21) to insert sluices, rebuild certain locks and demolish certain weirs. This was not carried out (see above **Historic mapping**).

Historic popular accounts directly relevant to the Severn weirs

South Wales Daily News (1889a)

The Severn Commissioners, a body composed of representatives of various public bodies within the catchment of the River Severn, are to promote a Bill for the improvement of the river. The works will comprise dredging, the enlargement of certain locks and the building of a new dock at Diglis to permit vessels of up to 400 tons burden to connect Bristol directly with Worcester. The cost of this is anticipated to be £25000.

South Wales Daily News (1889b), Western Mail (1889) and Worcester Echo (1889)

Discussions were held at Newport Town Hall between the Worcester Chamber of Commerce, the town council, the harbour commissioners and the Newport Chamber of Commerce with regard to making the Severn navigable for vessels of 300 to 400 tons burthen instead of 60 tons as at present, [these being the Severn Trows]. The Severn Commissioners, who have given notice of their intention to promote a bill in Parliament for the carrying out of improvements having no funds of their own, require that both the expense of the works and the cost of obtaining the Act should be provided. It was needful to have the waterway as a competitive traffic route to the railway. The present rates for carriage of timber from Cardiff to Worcester by railway were 7s 6d (37.5p); by water in the present small vessels 5s 6d (27.5p). It was anticipated that with the use of the larger vessels, this rate could be reduced to 4s 0d (20p). Instances were given of considerable delays occasioned to goods at Gloucester docks, sometimes extending to months, while awaiting shipment on the small vessels currently employed. It was noted by the Gloucester dockmaster that these delays were often caused by the trows having to wait for wind and weather.

Works on civil engineering of general relevance to weirs

Various general works on civil engineering, that were broadly contemporary with the construction of the Severn weirs, were consulted in order to establish what was common knowledge and practice at the time.

The Roorkee Treatise (1873)

The Roorkee Treatise on civil engineering in India (Medley 1873) does not deal directly with weirs. It does, however, comment on masonry dams and some of its general remarks may be relevant. Medley noted that in the interests of stability, the pressure to which the structure was subjected should be evenly distributed through the work. In order to achieve this the structure should be one homogeneous mass, built in every part of the same kind of material. No interior or exterior facing of ashlar, which may have a tendency to separate from the rest of the work and no <u>partial</u> use of cement or concrete should be permitted. In order to increase the resistance to sliding, horizontal courses must be rigorously avoided (the bed joints of such courses tending also to become channels for the passage of water. The structure must simply be a mass of uncoursed rubble laid in hydraulic mortar, without any hollows, every portion resembling the rest of the work as closely as possible.

The use of uncoursed rubble requires unusual care and vigilance in superintending the construction in order to insure that every stone be thoroughly and firmly embedded and that there are no empty hollows in the interior of the wall, nor spaces filled with mortar alone where stones ought to be placed. In such work, the practice of 'grouting' or filling hollows by pouring in liquid mortar should be strictly prohibited. Should it be decided to insert in the face of the wall headers or long bond stones, these stones should be laid with their lengths not horizontal but normal to the face of the wall.

The foundation should be sound rock if practicable.

Water Engineering (1888)

The theory regarding how weirs influenced the flow in rivers was summarised by Slagg (1888). The extent to which a weir influences the height of the water in the river above it - the amplitude of the backwater - can be found approximately for any weir, the circumstances of which are known, together with those of the river. Fig 3.3 (Slagg 1888, fig 55) is a section of such part of the river above a weir as is influenced by the backwater, the vertical scale being exaggerated compared to the horizontal. If A-B represents the surface of the river in its original state and a weir or dam be erected in the position shown, the water will pass over it at a height C due to the quantity and the length of the weir. If from that height C a line be drawn horizontally upstream until it cuts the surface of the original flow at D, as represented by the dotted line C-D, that distance, from C to D, will be about half the distance to which the surface of the water in a regular channel will be influenced by the erection of the weir; that is to say, it will be so influenced as far up as the point E, twice the distance C-D. The authorities give the distance C-E as being from 1.5 to 1.9 times the distance C-D; but if twice that distance be taken, it will allow a margin for error and will give the utmost limit of the backwater. From that point upwards to the next weir the river remains uninfluenced by the weir below; but it is only in rivers with considerable fall, or where there are but few weirs, or when the weir raises the height of the water but little above its original level, that there is any great length of river thus uninfluenced, in the ordinary state of the flow of the river; but the influence of the weir becomes less and less as the quantity of water coming down the river increases until, in a very high flood, when the weir becomes drowned, its influence in checking the flood is but little

Archaeological recording projects

Only two reports of recorded weirs were found, both of Powick Weir on the River Teme, a tributary of the Severn a little to the south of Worcester (Fig 1; Cook 1996 and Edwards and Cook 2000). Powick Weir was recorded prior to its demolition and replacement with a modern structure. A section through the structure was available along the line of a spill weir.

The earliest identifiable phase (undated, but probably in place by 1795) was thought to be a stone structure supported upon a large number of iron-shod wooden piles. The spill weir was lined with large ashlar stone blocks which facilitated and incorporated a vertical slot presumably for a timber or timbers forming part of the spill weir mechanism or stop planks for maintenance and the remains of a cutwater.

The upstream face of the weir was constructed of similar ashlar blocks. The downstream face was surfaced with pitched stone with a core of large ($c \ 0.2m \times 0.3m$) rubble stone (Edwards and Cook 2000; fig 3). Where the core had eroded, timber stakes and lacing were visible. Iron-working hearth bases were also employed, the latter being a waste product whose attractions were probably that they were heavy, locally available and practicably indestructible.

Two date stones (1826 and 1854) presumably identify the dates of repairs which may have included various areas of brickwork. Twentieth century repairs were executed in steel and concrete.

Discussion and commentary

The dating of the weirs

Under the *The Severn Navigation Act 1842* the Severn Commissioners were empowered to construct first Lincomb lock and weir (completed on the 30th December 1843). Thee months having expired with no apparent damage having been caused by the works, the construction of the other locks and weirs was proceeded with. These were the weir at Holt (completed on 19th June 1844) and those at Bevere and Diglis (completed simultaneously on 19th October 1844).

During the construction of the locks, and weirs and for two years afterwards, the Severn Commissioners dredged the fords and shoals below Worcester but within a month of the dredgers ceasing to work the shoals would return. Between 1847 and 1852 the Commissioners made three

applications to Parliament to construct a lock and weir at Upper Lode near Tewkesbury. The Royal assent was finally granted on 14th June 1853. The lock and weir at Upper Lode was completed on 10th August 1858.

The presence of fish passes

It is apparent that there were already fish passes in at least some of the Severn Navigation weirs and these could be dispensed with as better ones were already in existence.

Three weirs are named that had fish passes: Bevere, Holt and Lincomb although alterations were required to ensure that these fish passes complied with the Salmon Fisheries Act 1861.

Engineering principles and practice

There is no fundamental difference between the construction of a dam and a weir (Novak *et al* 1990). Generally speaking, weirs are relatively low-level dams, constructed across a river to raise the river level sufficiently to provide a source of power or allow for navigation. Dams and weirs are individually unique structures. Irrespective of size and type they demonstrate great complexity in their load response and in their interactive relationship with site geology and hydrology. In recognition of this, and reflecting the indeterminate nature of many major design inputs, dam engineering is not a stylized and formal science. Every structure represents a design solution specific to its site circumstances. The design therefore also represents an optimum balance of local technical and economic considerations at the time of construction.

Early dams and weirs were usually of the embankment type which includes the examples at Powick, Upper Lode, Diglis, Bevere, Holt and Lincomb. These were constructed of earth or rockfill. Upstream and downstream face slopes were usually similar, although the only available comparator, Powick, was noticeably asymmetrical. Such weirs are of moderate angle giving a wide section and a high construction volume relative to their height again, as at the examples above.

In its simplest and oldest form the embankment dam was constructed with low-permeability soils to a nominally symmetrical profile. The section featured neither internal drainage nor a cut-off (see below). Such a dam has been investigated at Rockley Smithies in Yorkshire where a clay and gravel bank was revetted with stone (Raistrick 1972). Dams of this type proved vulnerable to problems associated with uncontrolled seepage but there was little progress in design until the 19th century. It was then increasingly recognised that, in principle, larger embankment dams required two component elements. The first was an impervious, water-retaining element or core of very low permeability soil (eg soft clay or 'puddle' clay). The second were supporting shoulders of coarser earthfill (or of rockfill) to provide structural stability.

As a further design principle, the shoulders were frequently 'zoned' with finer soils adjacent to the core element and progressively coarser fill material towards either face. A cut-off is a measure to prevent seepage around and under the flank of a dam. They are generally formed by the excavation of wide trenches, backfilled with rolled clay.

At the time that Medley wrote the Roorkee treatise (1873) it was known that the pressure to which such a structure was subjected should be evenly distributed through the work. Achieving this required the structure to be one homogeneous mass, built in every part of the same kind of material. He advocated not employing ashlar masonry, either on the interior or the exterior, as it could separate from the rest of the work. Horizontal courses should be avoided, the structure being a mass of uncoursed rubble laid in hydraulic mortar. There should be no voids in the interior of the structure, nor should spaces be filled with mortar alone. In particular he thought that the practice of 'grouting' or filling hollows by pouring in liquid mortar should be strictly prohibited. This last stipulation has a more recent resonance. At Sheffield Lock on the Kennet and Avon Canal repairs from the late 1970s onwards included resealing of the joints between timber posts and horizontal arched lock walls (Cook and MacLeod 2016).

These joints had opened up, resulting in loss of the fine components of the fill behind the lock walls and the saturation of this fill. The method of repair was to auger holes behind the posts and introduce grout under pressure. A British Waterways engineer, at the time, had expressed concern in a memo that this procedure was ineffective. That he was right to be concerned was demonstrated by the sections that were recorded during the excavations for replacement of tie rods. These clearly showed that the grout, where it was present, was situated between 0.3 to 0.5m behind the king posts (ie it had failed to reach the joints that it was supposed to seal) and that it was discontinuous.

Medley (1873) also noted that the foundation should be sound rock if practicable. Presumably, the foundation at Powick was river gravel or other such soft material as it was necessary to employ a lattice work of wooden piles and other timbers in order to provide a sound foundation. This form of construction is reminiscent of 'starlings' commonly used in the construction of bridge abutments in medieval times, such as Old London Bridge (http://oldlondonbridge.com/tudor.shtml), where the foundations of the bridge were formed by driving piles into the mud and erecting upon them stone piers. Timber tie beams were in common use on the canal network, employed, for example, in the construction of lock chambers (eg Coxah and Gardner 2003, Cook and MacLeod 2016) and bridge abutments (Cook and MacLeod in prep). This is probably because, at the time, timber was the only structural material, readily available that, in a relatively slender member, could reliably resist tension. It is unknown to what height the timber elements of Powick Weir extended above water level or into the superstructure of the weir. However, there is the possibility that such a timber matrix might be found within the weirs in question during any excavations for the fish passes.

The weir at Powick, believed to be of late 18th century date, appears to be a hybrid design comprising an upstream face of ashlar stone backed by an embankment constructed with iron-shod wooden stakes and timber lacing. On occasions in the past, notably 1826 and 1854, it was necessary to carry out major repairs, the most recent of which consisted encasing most of the structure in concrete.

Evidence from archaeological recording

The information from Cook (1996) and Edwards and Cook (2000) was combined to produce a typical cross section and foundation plan for a river weir of the early to mid 19th century constructed on granular material (Figs 3.1 and 3.2).

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Archive

The physical archive consists of:

1 Hard copy of the report

It will be deposited at the Waterways Trust Archive upon approval of the report.

The digital archive consists of:

1 Digital copy of the report (.pdf format) It will be deposited with OASIS upon approval of the report.





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Fig 2.20: Upper Lode, 1921

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Upper Lode







Holt



2

Lincomb



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upstream



In the interests of stability the pressure to which the structure is subjected should be evenly distributed through the work. The structure should be one homogeneous mass, built in every part of the same king of material. No interior or exterior facing of ashlar, which may have a tendency to separate from the rest of the work, and no partial use of cement or concrete should be permitted. In order to increase the resistence to sliding horizontal courses should be rigorously avoided (the bed joints of such courses tending also to become channels for the passage of water). The structure must simply be a mass of uncoursed rubble laid in hydraulic mortar.

The use of uncoursed rubble requires unusual care and vigilance in superintending the construction in order to insure that every stone be thoroughly and firmly embedded and that there are no empty hollows in the interior of the wall, nor spaces filled with mortar alone where stones ought to be placed. The practice of 'grouting' or filling hollows by pouring in liquid mortar should be strictly prohibited.



Medley 1873

water level

The form arrived at [for the Severn weirs] was a solid weir with a level crest from end to end and without sluices or means of passing off the water other than over its top. The back of the weir was rounded off to a parabolic curve instead of being, as most weirs of the kind are, flat on the top.

downstream

Slagg 1888

Fig 3.2: Powick Weir showing wooden piles (after Cook 1996 and Edwards and Cook 2000)

Appendix 1: Information gathered in support of the construction of weirs and locks

Document 1

List of vessels (trows	s) lost on the River Seve	ern between 1810 and 1841	
Name of vessel	burthen	Name of vessel	burthen
Sarah	50	Sister	58
Ann	50	Trial	54
George	60	Severn	54
Happy Return	60	Fame	60
Albion	50	Defiance	60
Норе	50	Lark	50
John	54	Friends	60
Elizabeth	50	Britannia	60
Thomas	45	Ann	60
Success	50	Richard	60
Commerce	75	Defiance	60
Providence	50	John	50
Elizabeth	50	Brother	50
Surprise	60	Mary	100
Providence	50	Rose	74
Industry	160	William	50
Trusty	50	Fily	50
Wolf	50		

Document 2

A table showing the comparative rate of expense conveying a barge of 60 tons to and from Stourport and Gloucester exclusive of lighterage

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With from 5 to 6 feet of water the cargo could be conveyed in one barge or trow and the expense would be as under:

	£	S	d	
3 mens' wages at 13%	2	5	0	
meat, beer, bread, etc for 6 day's voyage	1	16	0	
One horse from Gloster to Diglis	2	18	11/2	
3 horses from Diglis to Stourport	3	7	3	
Horse driver's meat, beer and bread			8	0
Horse lines 20s, wear of barge, etc 20s	2	0	0	
	12	14	41/2	

With 2 feet 6 inches of water the same cargo would require 2 barges and the expense would be as under:

	£	S	d	
6 mens' wages at 13%	4	10	0	
meat, beer, bread, etc for 6 day's voyage	3	12	0	
2 horses from Gloster to Diglis	5	16	3	
4 horses from Diglis to Stourport	4	9	8	
Horse driver's meat, beer and bread			11	0
Horse lines	1	10	0	
Wear of barges, ropes, clothes, etc	2	10	0	
	22	18	11	

With 2 feet the same cargo would require 3 barges and the expense would be as under:

	£	S	d
9 mens' wages at 13%	6	15	0
meat, beer, bread, etc for 6 day's voyage	5	8	0
3 horses from Gloster to Diglis	8	14	41/2
6 horses from Diglis to Stourport	6	14	6
Horse driver's meat, bread and beer		14	0
Horse lines	2	0	0
Wear of 3 barges, ropes, clothes, etc	4	0	0
	34	5	111/2

Document 3Calculation of gain on working a canal boat of 28 tons burden between Gloucester and Worcester if Severn improvedAt presentVoyages per annumaverage cargo2222506If Severn improved

If Severn improved		
Voyages per annum	average cargo	total tonnage
33	28	924
	consequent increase	418

Besides saving expense of present lightering and wear and tear of boat, etc

Document 4

Table showing the number of days in which there was less than 3 and less than 4 feet of water over the Ketch Shoal between Worcester and Gloucester in 1836, 1837 and 1838

		number of days under 3 feet	number of days under 4 feet
1836	April	-	6
	Mav	23	31
	June	29	30
	July	26	30
	August	30	31
	September	23	29
	October	5	19
	November	1	6
	December	-	6
1837	January	1	7
	February	-	_
	March	1	22
	April	12	29
	May	14	27
	June	20	27
	July	30	30
	August	18	29
	September	12	22
	October	15	20
	November	-	-
	December	-	3
1838	January	8	22
	February	17	21
	March	-	2
	Total d	lays 285	449

Document 5

Table showing the number of days in which there was less than 3 and less than 4 feet of water over Redstone Rock near Stourport from April 1836 to April 1838

			number of days	number of days
1836	April		-	12
1050	May		30	31
	Iune		30	30
	July		30	31
	August		30	31
	Sentember		28	30
	October		15	22
	November		15	8
	December		1	6
1827	Inpuery		5	13
1057	February		5	15
	Marah		- 12	-
			12	27
	April		23	30 28
	Iviay		25	28
	June		25	29
	July		30	31
	August		24	29
	September		20	24
	October		18	22
	November		-	5
	December		-	10
1838	January		18	25
	February		19	21
	March			8
]	Fotal days	385	502

Appendix 2: Estimates for the carrying out of different improvement schemes

Document 1 Estimate for the improvement of the Severn 1841 from WA Provis

Location Upton Ham	Activity Cut, fencing etc Lock Weir	Estimate £4656 17s 6d £6321 4s 2d £3887 3s 9d	Sub-total £14865 5s 5d	Total
Worcester	Cut, fencing etc Lock Weir	£4210 8s 4d £6321 4s 2d £2848 3s 8d	£13379 16s 2d	
Bevere	Cut for weir Lock and cofferdam Weir	£1082 18s 0d £10768 18s 7d <u>£1569 14s 7d</u>	£13421 1s 2d	
Holt Fleet	Cut, fencing etc Lock Weir	£3347 8s 1d £5863 17s 8d <u>£1658 3s 1d</u>	£10869 8s 10d	
Lincomb Hill	Cut, fencing etc Lock and dams Weir	£5126 0s 0d £8072 0s 0d £2016 15s 0d	£15214 15s 0d	
5 Lock houses Dredging Protecting side 10% contingenc Exclusive of lan	of river cies			£67750 6s 7d £1250 0s 0d £18141 10s 0d £33866 0s 0d £12100 15s 7d £133108 12s 2d

Document 2 Estimate for the improvement of the Severn 1842 from WA Provis (estimate to take account of document below)

Worcester	Cut, fencing etc Double lock Weir	£4493 9s 2d £10349 8s 3d <u>£2848 3s 8d</u>	£17691 1s 1d	
Bevere	Cut for weir Lock and cofferdam Weir	£1082 18s 0d £10768 18s 7d <u>£1569 14s 7d</u>		
			£13421 1s 2d	
Holt Fleet	Cut, fencing etc Lock	£3347 8s 1d £5863 17s 8d		
	wen	<u>11038 38 10</u>	£10869 8s 10d	
Lincomb Hill	Cut, fencing etc Lock and dams Weir	£5126 0s 0d £8072 0s 0d £2016 15s 0d		
	Wen	<u>22010 135 04</u>	£15214 15s 0d	
4 Lock houses				£57196 6s 1d £1000 0s 0d
Dredging				£25737 15s 0d
Stoning banks				£45762 10s 0d
10% contingenc	ies			<u>£12969 13s 1d</u>
				£142666 4s 2d

Document 3 Reasons for placing the proposed lock and weir below the entrance of the Birmingham and Worcester Canal rather than above it, as advocated by the Birmingham Canal Company (see estimate above)

The land necessary for the cut and works below is less by one third than if they were removed [located] above.

The proposed works will not interfere injuriously with any property adapted to the erection of mills, warehouses, etc requiring a water frontage but on the contrary will render valuable for such purposes the land lying between the Cathedral and the Birmingham and Worcester Canal at Diglis whilst to place the weir above that canal would render almost valueless the only piece of building land adapted for docks, wharfs, etc which this measure is calculated to improve and on a portion of which a mill is already being built the suggested alteration would place the weir opposite to these premises thus render their Severn frontage useless and it would be dangerous to have to load or discharge vessels immediately at the head or tail of the weir. Thus the present plan excludes advantages to the UNREADABLE prospects of Worcester which any deviation therefrom must cripple, and as the Corporation are the conservators of the river down to the enhance[ment] of the Birmingham and Worcester Canal they would resist to the utmost any such attempt to restrict the advantages of the improvement.

The erection of the weir above and so near the mouth of the canal would lend to choke up its enhance[ment] and entail upon the promoters of this measure the great expense of reconstructing the canal lock.

With a lock above the canal boats coming thereout for Worcester will have to go a considerable distance down the stream before entering the proposed cut and then return making a very circuitous and inconvenient navigation and before coming up the river for the Worcester and Birmingham Canal would have to be hauled against the wash of the weir to the enhance[ment] of the canal thus increasing the labour of that portion of the navigation.

The site proposed by Mr Cubitt is free from all these objections the only argument used against it being that delay will arise to the Birmingham trade in passing through the proposed lock. In order to meet this objection a clause is inserted in the Bill requiring the erection of two locks parallel to each other to give increased facilities for the passage of boats and thus it will be impossible for any delay to occur to that trade since as the Birmingham and Worcester Canal enters the Severn by a lock with a greater lift of water than those proposed to be erected in the Severn it must be evident that boats can be delivered from the Severn Lock as rapidly as they can be supplied from the canal.

The only other observation that need be made on the subject is a legal one. To forego the present site would cause the loss of the Bill as no notices have been given for taking any other and Parliament would not sanction any plan where the standing orders had not been complied with and the land which would be required for the works if their petition was changed belongs to parties incapable of giving a valid consent.

Appendix 3: In the matter of stopping up unnecessary fish passes in the Severn navigation weirs (Southall 1885-1887)

Thomas Southall 1885-1887 In the matter of stopping up unnecessary fish passes in the Severn navigation weirs

July 18 1885

Instructions to apply to the Conservators of the Severn Fishery District to enter into an agreement under Section 23 of the Severn Navigation Act 1881 for the stopping up and removal of the fish passes in some of the Severn Navigation Weirs which had become unnecessary owning to the existence of a more perfect fish pass in each of such weirs. 6s 8d

Attending your engineer, Mr H J Marten, confirming as to his obtaining particulars of the fish passes. 6s 8d

August 10 1885

Attending Mr Marten, confirming as to the fish passes to be allowed and arranging to write to Mr John Stallard Junior, the Clark of the Conservators, thereon pursuant to the directions of the Committee. 6s 8d Letter to Mr John Stallard Junior informing him of your application and requesting him to bring same before the Conservators. 5s

August 11 1885

Received from Mr Stallard a letter enquiring whether I could arrange for his Committee to inspect the passes before their meeting on the 27th instant [of this month]. 5s Letter to him replying in the affirmative. 3s 6d

August 15 1885

Received from Mr Marten particulars of the fish passes in the form of a report thereon, dated the 14th instant. 3s 6d Perusing same. 2s 6d Attending meeting of the Committee when they authorised Mr Marten to act on your behalf in the negotiations with the Fishing Board. 2s 6d

Letter to Mr Bund informing him thereof in reply to a letter from him. 3s 6d The like to Mr Stallard. 3s 6d

August 29 1885

Attending meeting of the Committee when Mr Marten read a report dated this day of the inspection by Mr Bund and himself of the fish passes on the 28th instant and as to the arrangements which would be satisfactory to the Conservators and taking instructions to confer with Mr John Stallard Junior. 6s 8d

September 5 1885

Copy of the report folios 11. 3s 8d

Letter to Mr Stallard therewith and with a print of the Severn Navigation Act 1881 and that I should be glad to confer with him thereon. 3s 6d

September 12 1885

Attending Mr John Stallard Junior, conferring as to the course proposed at the inspection on the 28th ultimo [of last month] not being in accordance with the requirements of the Act and pointing out that the riparian owners might object if the Act was not complied with. 6s 8d

October 8 1885

Journey to Shrewsbury. Attending meeting of the Conservators when the Chairman reported the position of the matter, and he was authorised to make an arrangement with you for the temporary stopping up of some of the passes in one of the weirs and (if necessary in his opinion) for the temporary enlargement of the remaining pass in such weir, but no resolution was passed thereon and journey home engaged all day. £3 3s Railway fare and expenses. £1 6s

October 10 1885

Attending meeting of the Committee reporting my attendance at the meeting of the Conservators. no charge Letter to Mr Stallard requesting him when he had prepared the minutes of the meeting on the 8 instant to send me a copy of so much as related to this matter, and a similar extract from the minutes of the meeting of the Executive Committee on the 27th August last. 3s 6d

December 22 1885 Received from Mr Stallard extracts from the minutes accordingly. no charge Letter to him acknowledging the receipt thereof. 3s 6d Perusing same. 2s 6d January 19 1886

Letter to Mr Stallard that from the annual report of the Executive Committee of the Conservators I observed that a proposed agreement between you and the Conservators was to be laid before a meeting of the Committee of the Conservators on the 21 instant and requesting him to send me the draft or a print of it, as I should like to see it before the meeting. 3s 6d

January 26 1886

Received from Mr Stallard a letter that Mr Marten's report contained the terms agreed upon between him and Mr Bund. Letter to him that Mr Marten's report could not in any way be considered an agreement by the Commissioners. 3s 6d

January 30 1886 Letter to Mr Stallard suggesting some alterations in the draft report of the Conservators so far as it related to this matter. no charge

February 5 1886 Received from Mr Stallard a letter that his chairman would agree to my suggestion as to the wording in the report of the Conservators. no charge

February 12 1886 Received from Mr Stallard a letter that he had instructions to withdraw the agreement from the appendix to the report. no charge

February 13 1886

Attending meeting of the Committee laying before them the correspondence with Mr Stallard and taking instructions to arrange with him for the preparation of a draft of an agreement for the removal of the unnecessary fish passes pursuant to the provisions of section 23 of the Severn Navigation Act 1881. 10s Letter to Mr Stallard thereon and enquiring if I should prepare and send him draft agreement, or whether he would prefer to prepare the draft. 3s 6d

February 16 1886 Received from him a letter asking me to prepare the draft agreement. no charge

February 18 1886 Instructions for agreement accordingly. 10s Drawing same, folios 16. £1 12s

March 26 1886 Drawing instructions to Counsel to settle same on your behalf, folios 11. £1 2s Copy thereof. 3s 8d Copy for Counsel. 3s 8d Copy of Mr Marten's report dated 29 August 1885 to accompany. 3s 8d Copy of sections of the Severn Navigation Acts and the Salmon Fishery Acts having reference to the fish passes on the Severn Weirs, folios 45. 15s Letter to Counsel with the instructions and papers. 3s 6d Fee to him and clerk herewith £2 4s 6d

April 11 1886 Received from Counsel the papers. no charge

April 13 1886 Copy of the draft agreement. 5s 4d Letter to Mr Stallard therewith. 3s 6d

April 15 1886 Journey to Gloucester attending meeting of the Conservators whom an order was made for sealing the agreement and journey home. no charge Railway fare and expenses. 11s 6d

April 20 1886

Attending Mr Stallard, conferring as to the alterations required by the Act to be made in the passes that would remain, when he wished measurements to be made of the apertures of the existing passes and arranging to request Mr Marten to arrange for this to be done. 6s 8d

Letter to Mr Marten accordingly, and that it was desirable that he and Mr Bund should be present when the measurements were taken. 3s 6d

May 10 1886

Attending Mr Stallard who said that Mr Bund would be unable to go up the river at present and conferring on the course to be pursued. 6s 8d

May 12 to July 29 1886

Several attendances and letters as to going to measure the fish passes. no charge

August 28 1886

Letter to Mr Stallard informing him (in reply to one from him) that the 3 proximo [of next month] would suit me for the inspection of the fish passes, but that Mr Marten was at Vichey, and would not be back by that day * * * - and naming other days that he might select one suitable to Mr Willis Bund and himself. 3s 6d

September 2 1886

Attending Mr Bund and Mr Stallard fixing the 17 instant for the inspection. 6s 8d Letter to Mr Marten informing him thereof. 3s 6d

September 11 1886 Attending meeting of the Committee reporting the arrangements made. no charge

September 17 1886

Journey with your engineer, Mr Bund, Mr Berrington, the Inspector of Fisheries, Dr Day and Mr Stallard up the river inspecting the fish passes and the measurements thereof were taken; occupied all day. £3 3s Expenses paid by Mr Marten.

September 25 1886 Attending meeting of the Committee when the Engineer reported what had been done. no charge

September 28 1886

Received from Mr Marten a letter dated the 27 instant stating the measurements of the passes and the alterations to be made in those to remain. no charge

October 1 1886

Copy of the letter dated the 27 ultimo from Mr Marten, folios 15. 5s Letter to Mr Stallard therewith, and that the Conservators had now to determine whether they would have the openings in the passes that are to remain lengthened or deepened or a combination of both of those alterations and to let me hear from him thereon, so that their agreement might be completed. 3s 6d

October 9 1886

Attending meeting of the Committee laying before them a letter dated the 2 instant from Mr Stallard asking for payment by you of his professional charges in this matter and taking instructions to inform him that the Committee would pay him the usual professional charges as to the perusal and completion of the proposed agreement. no charge Letter to him accordingly. 3s 6d

November 3 1886 Received from Mr Stallard a letter as to some discrepancy between his measurements and those stated in Mr Marten's letter. no charge Copy of such letter. 1s Letter to Mr Marten therewith. 3s 6d

November 6 1886 Attending Mr Marten who said he had seen Mr Stallard and agreed on the measurements. no charge

January 15 1887

Letter to Mr Stallard for the decision of his Board as to the dimensions by which the openings of the continuing passes were to be enlarged. 3s 6d

January 21 1887

Received from Mr Stallard a letter that at a meeting of his Board yesterday, the Chairman received authority to arrange the manner in which the continuing passes should be enlarged so as to comply with the Act and that before arranging this, the Chairman would like to again inspect the passes. no charge

Letter to him that I feared this would necessitate a delay of some months until the water was low. 3s 6d

January 29 1887

Attending meeting of the Committee reading the letter from Mr Stallard and copy of my reply. no charge

April 2 1887

Received from Mr Stallard a letter that he thought his Chairman would be in the neighbourhood next week and might then attend the further inspection. no charge Letter to him in reply thereto. 3s 6d

April 9 1887

Received from him a letter that owing to illness, Mr Bund was obliged to return to London. no charge

April 13 1887

Attending Mr Marten and with him on Mr Stallard conferring on the proposed inspection and on the means of altering the remaining fish passes in Bevere weir to comply with the provisions of the Act. 6s 8d

April 15 1887

Letter to Mr Stallard that the postponement of the further inspection might prevent the work being done this year and requesting him to ask Mr Bund if he could not dispense with another inspection or deput it to some other member of his Board. 3s 6d

May 19 1887

Attending Mr Bund on his naming the 13 proximo for the further inspection of the fish passes. 6s 8d

May 21 1887

Letter to Mr Stallard informing him in reply to one from him that arrangements could be made for the 13 proximo. 3s 6d

May 28 1887

Letter to Mr Marten informing him of the appointment for the 13 proximo. 3s 6d

June 6 1887

Letter to Mr Stallard enquiring what hour on the 13 instant would suit Mr Bund and himself. 3s 6d

June 10 1887

Letter to Mr Stallard informing him (in reply to one from him) that the 'Dawn' should be at Worcester Bridge at 10.15 on the 13 instant. 3s 6d

June 13 1887

Journey up the river with Mr Bund, Mr Stallard and Mr Marten again inspecting the fish passes and arranging the alterations to be made in those which were to remain and journey home. Engaged all day. £3 3s Expenses paid by Mr Marten.

June 15 1887

Received from Mr Marten a letter setting out in detail the alterations arranged at the inspection. no charge Letter to Mr Stallard stating the particulars of the alterations to be made in the various fish passes and requesting him to insert same in the Schedule to the draft agreement and to send me the draft for engrossment. 3s 6d

June 16 1887

Received from him the draft agreement and a letter that he would let me have his engrossment thereof on the 18 instant. no charge

Letter to Mr George Edward Marten to bring with him to the meeting on the 18 instant the key of the Seal Box. 3s 6d

June 17 1887

Perusing the alterations made in the draft agreement and revising same. 5s Attending Mr Stallard, conferring thereon when he assented to the alterations made by me. 6s 8d Engrossing agreement – folios 16. 10s 8d Stamp and paper and parchment for making up. 15s

June 18 1887 Received from Mr Stallard his engrossment of the agreement. no charge Examining same with my engrossment thereof. 3s 4d Attending meeting of the Committee laying before them the engrossments when a resolution was passed directing the Seal to be affixed thereto and affixing same accordingly to the agreement and duplicates and instructions were given to the Engineer to carry out the alterations of the fish passes and also some alterations of the aprons of the weirs at Holt and at Lincomb required for improving the approach to the fish passes therein. 10s Letter to Mr Stallard with the two engrossments to be sealed by the Conservators and sending him an extract from the minutes of the meeting today showing the instructions given to the Engineer. 3s 6d Making extract to accompany same, folios 4. 1s 4d

July 1 1887 Letter to Mr Stallard for my engrossment of the agreement with the Seal of the Conservators affixed. no charge

July 11 1887 Received same from him. Letter to him acknowledging the receipt thereof. 3s 6d

July 16 1887 Attending meeting of the Committee laying before them the agreement duly sealed. no charge

Postages, messengers, etc 2s 6d

Total £30 5s 4d

1887 November 19 Received of you the above £30 5s 4d [Signed] Thomas Southall