THE FLOODS OF BATH

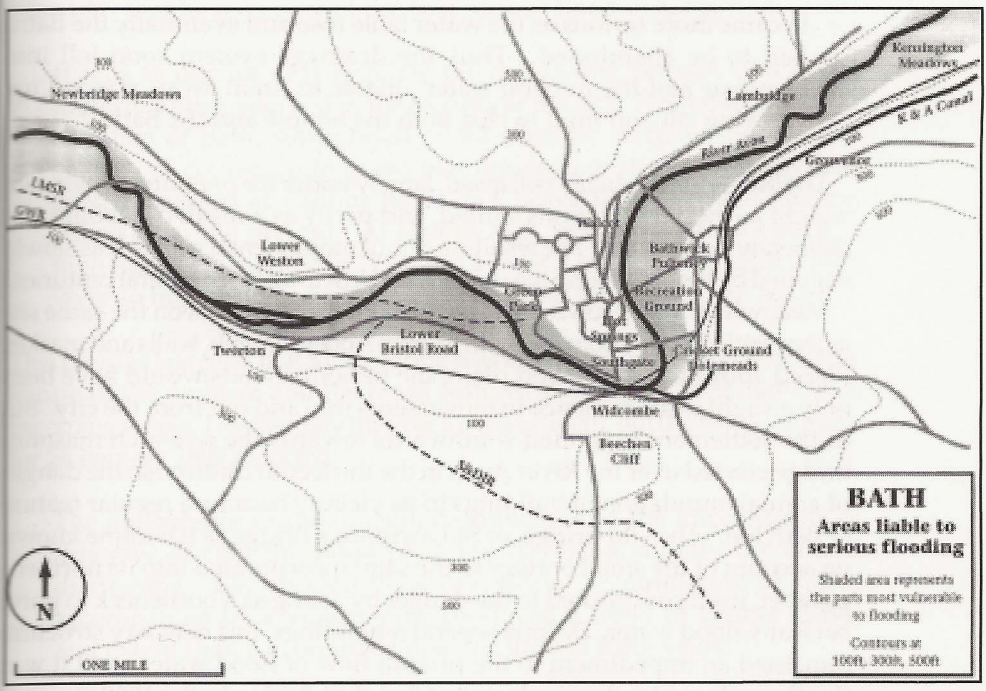
R. Angus Buchanan

On the evening of Wednesday 10th July 1968, West Country members of the Institution of Civil Engineers held a Reception in Bristol to celebrate the 150th anniversary of the foundation of the Institution in 1818. The guests assembled in the City Art Gallery, through the glazed roof of which the proceedings were punctuated by vivid flashes of lightning and tremendous cracks of thunder. A summer storm, which had already been rumbling for several hours, terminated a long period of drought with a phenomenal downpour of rain. Some of the speakers at the Reception were tempted to boast of the way in which engineering had successfully tamed the forces of Nature. In the event, this was an extraordinary declaration of *hubris*, because the storm wreaked exceptional havoc across the West Country. Underground aquifers erupted on the Mendips; rivers rose alarmingly; roads and embankments were washed away; and many bridges, including the County Bridge across the Avon at Keynsham and the bridge at Pensford across the Chew, were destroyed. In Bath, streams in all the tributary valleys flooded quickly and the Avon rose ominously. The way back to the city was blocked late that night by a torrent at the Saltford end of the newly-constructed Keynsham by-pass, and a double-decker bus was abandoned in flood waters at Pennyquick. The level of the Avon itself rose steadily until, by the afternoon of the next day, the river had flooded Southgate Street, as it had done so many times before.[1]

This, after all, was only the latest of a long series of floods which had regularly disrupted life and transport in the City of Bath, and had caused enormous damage to property over the years, even though there had been remarkably few fatalities. The sight of water lapping the parapets of the Old Bridge; of the inundation of large areas of Dolemeads, Avon Street, Green Park and Twerton; and of swans sailing up Southgate Street had become all-too-familiar features of Bath experience, and views which the citizens had come to take largely for granted in the eighteenth and nineteenth centuries. Even then, however, steps had been taken to alleviate the recurrent scourge of serious flooding, although most of the schemes which were considered were either inadequate or too expensive to be put into practice. With the twentieth century, the demand for effective action became more articulate, and after a particularly serious

inundation in 1960 the determination and resources were at last found. The scheme which resulted from this disaster was being put into practice when the summer flood of 1968 struck, but it proved to be the last occasion on which the River Avon was allowed to get seriously out of control in the centre of the city. It would be unwise to claim that such an event can never happen again, but within the limits of imaginable contingencies the engineering arrangements now in place should make a recurrence of serious flooding very unlikely.

The problem of flooding is one which affects all settlements adjacent to irregular and unreliable rivers. The Bristol Avon is as variable in its behaviour as any British river, subject to the range of the national weather which, although generally temperate, is notoriously unpredictable in detail. Downstream in Bristol its behaviour is complicated by the unusually high range of the tidal reaches as far as Netham Weir (and occasionally as high as Hanham Weir), and by its confluence with the River Frome in the centre of the city. In Bath, however, the water level is normally about 40ft above the highest level of the tide in Bristol, although the backing-up effect of a high tidal surge coinciding with a flood in the catchment area remains a remote possibility. The special features of Bath floods have been the result of a large increase in the volume of river water channelled by the topography of the Avon valley into a series of 'bottlenecks'. These have restrained the flow of the river and caused it to flood out over the narrow strips of low ground between the bluff on which the original settlement of Bath was built and the bulk of Beechen Cliff to the south. The growth of the city has involved increased pressure to build on this flood plain, and all the developments in Walcot, Bathwick, Dolemeads and downstream to Twerton and Weston have been hostages to the fortune of floods from the moment they were built. The first such development was from the traditional South Gate of the city to the Old Bridge – the Southgate Street which figures on maps from the sixteenth century.[2] But it was the popularity of the city as a spa town in the eighteenth century, and the flourishing industrial expansion along the river between the Old Bridge and Twerton in the nineteenth century, which caused the main encroachments on these vulnerable areas. They were all built-up except for the pieces which became the Recreation and Cricket Grounds, always prime victims of any flooding. At the same time, the building and paving of the city up both hillsides away from the river increased the volume of run-off water into the Avon and thus accentuated the danger of flooding in the low-lying areas (fig.1).



1. Bath: Areas liable to serious flooding.

While it is safe to infer that the valley of the River Avon has always been prone to flooding, this has only become a serious problem to the people of Bath with the growth of the city. The mineral springs which formed the nodal point of the original settlement emerged in a marshy declivity in the middle of a more or less level terrace which rose some 50ft above the normal level of the river. This would therefore rarely have been affected directly by flooding in the valley, although the backing-up effect of spring water unable to make its usual escape into the river would have added considerably to the marshiness in the vicinity of the springs. These effects were not sufficient to deter the Romans from establishing their great baths and temple complex on the site, and the complete settlement, as indicated by the line of the wall round the city, stood firmly on the terrace above the flood plain of the river. For the greater part of three centuries Roman engineering and drainage coped adequately with any tendencies to succumb to flooding.[3]

Towards the end of the Roman occupation, however, flooding became an increasing problem. Professor Cunliffe observes that, tackled at first by expensive re-floorings, the problem eventually:

became more serious as the water table rose and eventually the Baths had to be abandoned. Thus the drainage system soon fell into disrepair and the mineral water, unable to drain away, ponded up, allowing silt and mud to clog both the temple and the Baths.[4]

The buildings gradually collapsed, largely under the pressure of their own weight as their foundations shifted, and partly as a result of robbing and deliberate destruction. The resulting pile of monumental rubble was slowly engulfed by the silt around the springs, and lost to sight for several centuries.[5]

Meanwhile, a new town grew in the medieval centuries on the same site as that settled by the Romans, with its own Abbey Church, walls and market. Placed above the river flood plain, the periodic floods would have been only a slight inconvenience to movements into and out from the city. But as the settlement expanded southwards towards the five-arch masonry bridge erected over the River Avon in the thirteenth century, so the danger of annual inundation of buildings in its vicinity became a regular feature of Bath life.[6] The Old Bridge, or St.Lawrence's Bridge as it became known on account of the small oratory to the saint incorporated into its northern parapet, itself contributed to the danger by acting as a bottleneck to pond back any flood water. Despite several rebuildings, this masonry structure remained an impediment to the smooth flow of flood water until it was finally replaced by the single-span Churchill Bridge in the 1960s.[7]

Commentators on the Bath scene before the nineteenth century appear either to have taken periodic flooding for granted or not to have thought the subject worthy of mention, so that there is little documentary evidence of the problem. The Rev.Richard Warner, in his monumental work of antiquarian scholarship, *The History of Bath*, first published in 1801, discusses the use of the river as a highway for trade and as a source of power for mills but has nothing to say about it as a cause of floods.[8] Neither did John Wood in his valuable but idiosyncratic study, *A Description of Bath*, published originally in 1742-3.[9] We know from other sources that the 'Tempest' of 1703 caused extensive flooding and disrupted life over much of south west England; and that in 1774 another flood seriously damaged the 'new' bridge built by Ralph Allen for the Bath Turnpike Trust in the mid-1730s, so that it had to be rebuilt as the present single-span Newbridge.[10]

Only in 1838, with the appearance of *Annals of Bath from the year 1800*, by Captain Rowland Mainwaring, RN, do we find an attempt to record carefully the effects of floods in Bath. Mainwaring saw his study as a sequel to Warner, but by arranging his material in the form of a year-by-year chronology he was writing a different sort of book. It was under his heading for the

year 1809 that he took note of the first serious flood in his period:

> It falls to our lot next to relate the distressing ravages of a flood, hitherto unprecedented in the records of the city. From the particular situation of Bath, surrounded on all sides by steep acclivities, and subject, of course, to frequent overflowings of the river, many had been witnessed at various times, but never with such devastating effects as at the present. At Monks Mill, near the Orange Grove, a high flood was marked in 1725, and a second in 1774, neither of which were so high, by two feet and a half, as that which we now record.[11]

This passage suggests that Mainwaring was aware of both the long-standing nature of the problem and the novel features showing in 1809 that it was becoming worse. He cites only the year for the incident, but the Bath Chronicle for 26 January 1809 reported:

> The appearance of the immediate suburbs and the lower streets of this city during the noon of today has been equally novel and distressing. The sudden thaw of a heavy accumulation of snow, accompanied by a violent rain, produced a flood of greater depth and extent than has occurred here for the last forty years.[12]

The details given – the loss of seven lives in Bedford Street, off the London Road, where three houses were washed away, and the disruption of the mail coach – 'The Volunteer coach, in an attempt to force its passage through the waters, unfortunately lost two horses' – are also narrated by Mainwaring, who goes on to describe how the inhabitants of the Quay, Southgate Street, Milk Street and Avon Street 'were obliged to retreat to their upper apartments', and how in the Dolemead area:

> the most agonizing spectacle was that of a cradle floating down the stream, from which an infant now and then endeavoured to raise its head ...

The child was rescued at the Old Bridge.

Mainwaring also thought it worth mentioning, as an aspect of the singularity of the 1809 flood, that 'the magistrates and clergy' of Bath promptly raised a fund for the relief of distress which amounted to the considerable sum of £3,495. In an interesting comment on the spirit of the times he explains that the recipients were divided into two classes, one to whom grants of £5 or

less were made, totalling £1,008; and the other consisting of shopkeepers and suchlike who had lost property and stock, who received a total of £1,799. The remainder was dispensed on provisions, £355; rewards, £74; and advertisements, £16; leaving a balance for contingencies of £240.[13] It became a regular feature of these events to raise an appeal for flood relief, but the generosity of the response on this occasion was an indication of its novel seriousness, and inaugurated the modern period of Bath floods.

Several other floods were recorded by Mainwaring in the period covered by his chronology, especially in 1821, 1823, and 1828. For 1821 he reported:

> At the termination of the year, public attention was particularly called to the unfortunate inhabitants of those miserable abodes recently built on that low, swampy spot of ground, called the Dolemeads ... [where torrential rain in the last two weeks of December] ... caused the river to overflow its banks full twelve feet above the customary level; and the Dolemeads presented one immense sheet of water.[14]

But there were no fatalities as in 1809, and the relief fund amounted to a mere £881.[15] Dolemeads was again the main area to suffer in 1823, when heavy rain at the beginning of November brought renewed flooding to the lower end of the town:

> the view presented from the Abbey Tower was of the most desolate description. Several of the houses appeared with little more than their roofs above water; and the Avon rushed onward in its impetuous course, as if to overwhelm everything within its reach.[16]

On this occasion a load of timber was washed downstream and blocked part of the Old Bridge, contributing significantly to deepening the flood. For the first time, serious remedial measures were contemplated. Mainwaring observed:

> These frequent overflowings, and their lamentably devastating effects, at length called for the serious attention of the Municipal Authorities.

In the next year, 1824, a 'Flood Relief Committee' was established, and the great civil engineer Thomas Telford, at that time the leader of his profession, was invited to report on the situation. Telford responded with characteristic thoroughness, recognizing that the problem, although serious, was soluble by the provision of some fairly simple engineering works – removing obstructions to the flow of water, replacing the Old Bridge by a single arch

bridge (preferably in iron), and making some realignments in the course of the river. His estimated cost was £47,848 but when the Committee saw no hope of raising this sum Telford's report was shelved indefinitely.[17] The flood reported by Mainwaring in 1828 differed from its predecessors, which had all been winter floods brought on by heavy rain and/or melting snow, by coming in the summer months. This type of flash flood, following a violent summer storm, could cause serious damage in Bath, as we have already noted in that of 10th July 1968, so although less frequent than the winter floods they have to be reckoned with:

> On the night of 8th July, an alarming and destructive inundation occurred, occasioned by a tremendous fall of rain, so sudden and powerful that it appeared as if a huge water-spout had burst over the city, accompanied by thunder and extremely vivid lightning, and which continued, without intermission, for many hours.[18]

The storm caused the Widcombe Mill dam to burst, flooding the lower part of the village suddenly, including the *White Hart* public house, and several people were drowned.[19]

The next serious flood was a winter one, reported in 1841. Under the headline 'The overflowing of the Avon', the *Bath Chronicle* described the familiar situation:

> The rapid thaw which commenced on the night of Friday last caused a more extensive flood along the banks of our river than has been known since November 1823 ... The effects of the flood were, as usual, the most severely felt in the Dolemeads.[20]

After that, there appears to have been something of an intermission to 1866. There were certainly wet years with gales and snow in evidence, but none in which inconvenience to the citizens of Bath seems to have made an impression. The fact that the flood in January 1866 was also the first to be recorded on the southern abutment of the Widcombe Footbridge, and that this was probably the first year of the existence of the abutment, suggests that our records for the previous two decades may be deficient. However, the pattern of a couple of serious floods in every decade resumes at this point, and continues for a century thereafter. In 1875, there were two floods, one in the summer (July) and the other in the winter (November). The flood of October 1882 received full attention in the local press, with an emphasis on the remarkable number of horses, pigs, sheep and other animals lost. This is

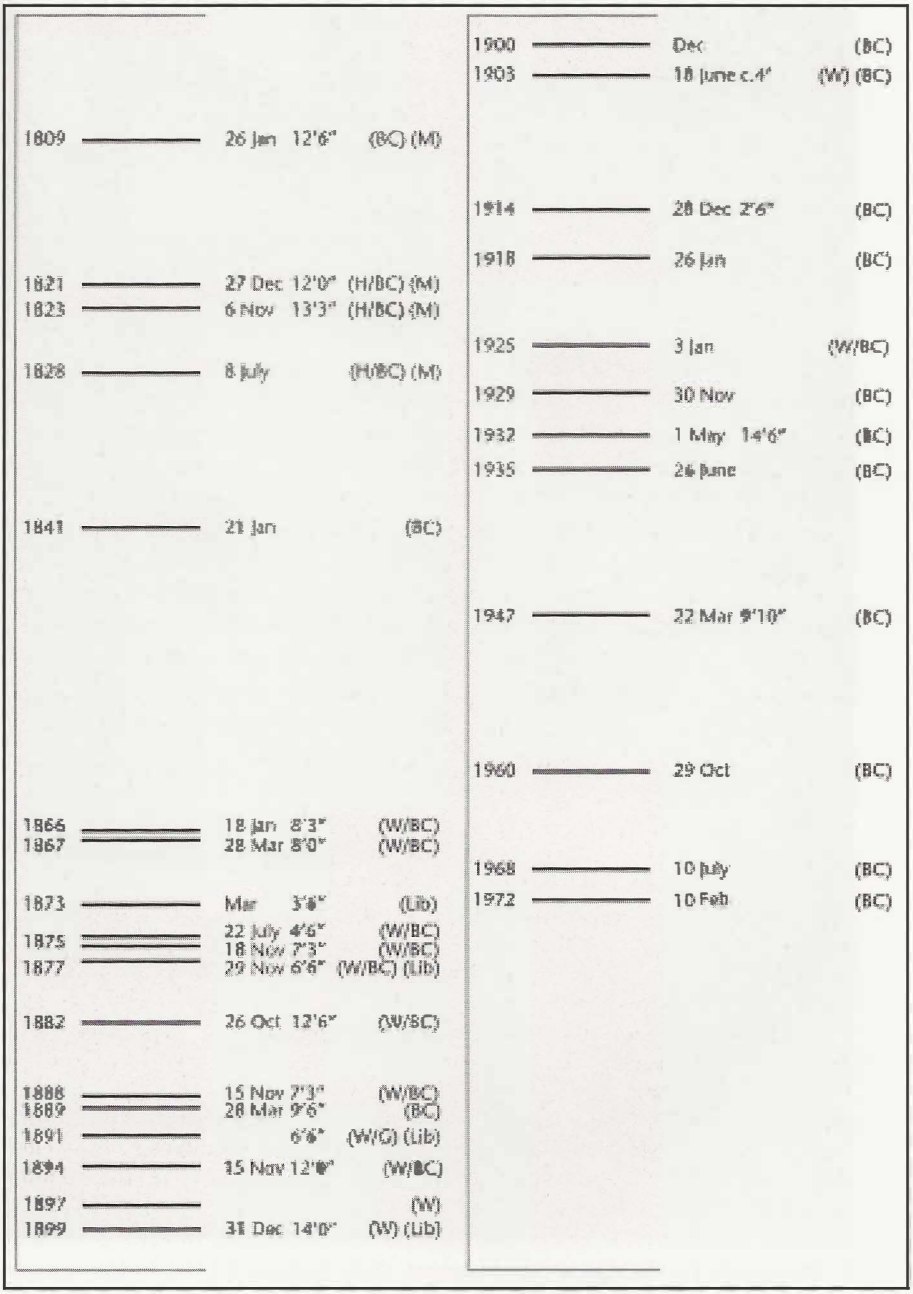
a reminder of the large population of animals normally resident in the town in the nineteenth century, not only in the transport service but also kept in back yards to supplement the diet. A widow living in a cottage near North Parade refused to be rescued from the flood in 1866 because she had moved her four pigs upstairs into her bedroom and intended to look after them there.[21]

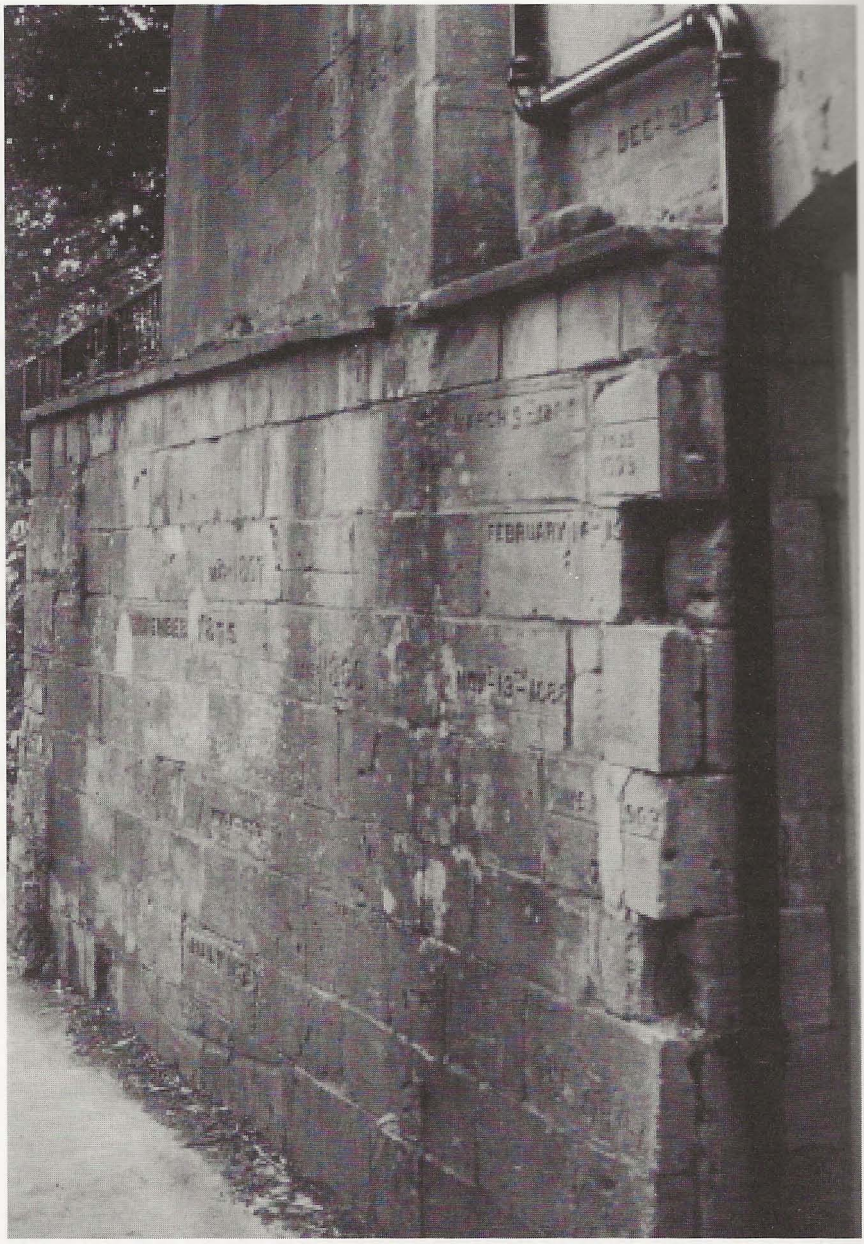
Newspaper comment on Bath floods increased in the nineteenth century with the emergence of popular local journalism, and flourished further in the twentieth century, aided by the advent of newspaper photography. It has to be admitted that the photographs were frequently dull and repetitive black and white images, but their drama lay in what they showed – the torrent lapping the parapets of the Old Bridge, or swans swimming up Southgate Street. The episodes do not bear detailed re-telling, as so many of the events recalled are depressingly similar. However, a glance at figure 2 will serve to indicate the incidence of serious flooding in Bath over the last two centuries, with as much of the available statistical information as is relevant to this pattern. It will be sufficient for our purposes to pick out a few of the highlights and more dramatic incidents. Fortunately, there were few fatalities involved in the Bath floods, so that newspaper comment tended to concentrate on the more bizarre and amusing incidents, and the narrative often assumed something of what a later generation would call the 'Dunkirk spirit', of adversity stoically and even heroically borne.

---

2. The incidence of floods in Bath (opposite).

- Heavy lines denote years in which serious flooding has occurred in Bath in the last two centuries.
- The month in which the flood occurred is indicated where known, showing that the majority of inundations were in the winter months (September to April) but that a significant minority may be regarded as summer flash floods (May to August). Specific dates generally refer to newspaper comments.
- The height of flooding is given where known, expressed in feet and inches as at the time of the incident. These figures are derived from several sources and are not completely consistent. They generally refer to the height above normal at Pulteney Weir. The most comprehensive set of figures is contained in a note in the Large Red Cutting Book on Bath Floods in Bath Central Library (B551.57BAT).
- Sources: the chart has been compiled from references in Bath newspapers, especially the *Bath Chronicle* which is available on microfilm in Bath Central Library (BC); R. Mainwaring, *Annals of Bath* (M); F. Greenhalgh, *Bath Flood Prevention Scheme* (G); and other Bath Library records (Lib). Also useful in filling in background information has been: Barry Horton, *West Country Weather Book* (1995) (H); and the physical evidence provided by flood marks on the south abutment of the Widcombe Footbridge (W) (fig.3).


1809 26 Jan 12'6" (BC) (M)
1821 27 Dec 12'0" (H/BC) (M)
1823 6 Nov 13'3" (H/BC) (M)
1828 8 July (H/BC) (M)
1841 21 Jan (BC)
1866 18 Jan 8'3" (W/BC)
1867 28 Mar 8'0" (W/BC)
1873 Mar 3'8" (Lib)
1875 22 July 4'6" (W/BC)
1875 18 Nov 7'3" (W/BC)
1877 29 Nov 6'6" (W/BC) (Lib)
1882 26 Oct 12'6" (W/BC)
1888 15 Nov 7'3" (W/BC)
1889 28 Mar 9'6" (BC)
1891 6'6" (W/G) (Lib)
1894 15 Nov 12'0" (W/BC)
1897 (W)
1899 31 Dec 14'0" (W) (Lib)
1900 Dec (BC)
1903 18 June c.4' (W) (BC)
1914 28 Dec 2'6" (BC)
1918 26 Jan (BC)
1925 3 Jan (W/BC)
1929 30 Nov (BC)
1932 1 May 14'6" (BC)
1935 24 June (BC)
1947 22 Mar 9'10" (BC)
1960 29 Oct (BC)
1968 10 July (BC)
1972 10 Feb (BC)



3. Widcombe Footbridge south abutment. (*R.A. Buchanan*)

On some occasions the newspapers published supplements to bring together their coverage of the bigger floods. This happened in 1894, and again in 1932 and 1968. The pamphlet reprinted from the *Bath Herald* in 1894 amounted to a sixteen-page dossier on the events of the 'Great Floods'.[22] The publishers claimed that 100,000 copies of the original newspaper reports had been sold. There was widespread agreement that the 1894 flood was one of the biggest. A contemporary comment claimed that:

> The present flood is the fourth great inundation of the city during the present century, the other three being 1809, 1823 and 1882. Of course there have been numerous other occasions ... when the river has risen to a great height, flooding the lower parts of the city, and causing great anxiety and distress ...[23]

On the same day in November 1894, the headlines in the *Bath Herald* told the story in outline: 'The Great Flood', 'Highest on Record', 'Exciting Rescues', 'Hundreds of People Homeless', 'Measures for Relief', 'The City in Darkness', and 'Collapse of Bathford Bridge'. The flood continued for three days following heavy rain at the beginning of November, and it had two distinct peaks, on 13th and 15th November. Gas-lighting was cut off to much of the city when a barge hit the gas main across the river at the gas works, so that the distribution system was flooded.[24] The newspaper claimed that the flood: 'reached the highest point ever recorded, exceeding even those early in the century which had hitherto held the record', and this judgment is supported by the levels inscribed on the Widcombe Bridge abutment, where that for 1894 is well above the next highest.[25]

Further flooding occurred in 1897, 1899 and 1903, according to the Widcombe Bridge floodmarks, but they received little newspaper attention, apart from the disruption of the Cricket Festival caused by the summer flood of 1903:

> The Recreation Ground presented a unique appearance, with the tents which had been erected in connection with the ill-fated Bath Cricket Festival, standing in about three feet of water, and the ground almost submerged.

The paper also recorded a flood, not marked on the bridge, in the first issue of 1901, but as this started on 24th December it should be regarded as an event of 1900.[26]

4. The River Avon in flood behind Claverton Street, before redevelopment, c.1960. (*Photograph by Rev.W.H.Parsons, reproduced by courtesy of K.Evans*)

There were then more wet winters, with 1914, 1918, 1925, and 1929 all producing inundations. Newspaper comment in January 1918 can be regarded as fairly typical. Under the heading 'The Avon in Flood', it reported:

> Though comparatively little damage was done, considerable discomfort and inconvenience were occasioned in Bath and district by the Avon rising so rapidly on Saturday afternoon and evening to the height of 10ft 6ins above its normal level. Happily on Sunday the water receded almost as quickly as it had risen and the high wind which blew in the latter part of the day had a welcome drying effect.[27]

Amongst the details reported, the road under the GWR bridge at Bathford was flooded, preventing trams from getting through; the meadows at Bathampton, Batheaston and Lambridge were flooded, as were the open spaces of the Recreation Ground and Cricket Club; the Grosvenor Suspension Bridge was cut off for some hours and its toll house isolated; parts of Dolemeads, the Lower Bristol Road and Oldfield Park were under water, preventing the trams getting through to Twerton; and the Rev.Richard

5. Southgate Street under flood water, looking towards the Old Bridge and Beechen Cliff, c.1960. (*Photograph by Rev.W.H.Parsons, reproduced by courtesy of K.Evans*)

W.Windsor of St.Paul's Vicarage appealed for help in support of his poor parishioners in Little Corn Street, The Quay and Lower Avon Street.[28]

In January 1925 a newspaper declared: 'Bath Floods – Worst Inundation for 24 Years – Hundreds imprisoned in their bedrooms'. The river was reported to be 12ft above normal, and the Dolemeads and Lower Bristol Road to be worst affected, while 'Southgate street was impassable this morning to all save dairy errand boys and water-loving dogs'. Under the heading 'Long Night of Terror' another newspaper reported: 'For the first time for years the Roman Baths have been flooded ... what is to become of the famous goldfish?'[29] The Mayor, Alderman Cedric Chivers, donated £100 'as the nucleus of a distress fund'.[30] This intervention by the Mayor represented a familiar pattern of aiding distressed victims of Bath floods. We have already noted Mainwaring's reports of such assistance in the early nineteenth century, and the Guildhall Archives contain a box of documents dealing with such formal appeals between 1875 and 1901. In each case, subscription books were opened in leading banks and institutions, and the sums raised varied from £2,328 in 1882 to a mere £199 in 1900. Allocations were then usually made through local clergymen and other public figures, a high proportion going to the residents of Dolemeads,

6. The River Avon in flood, looking downstream from the Old Bridge, c.1960. (*Photograph by Rev.W.H.Parsons, reproduced by courtesy of K.Evans*)

and being used to purchase coal to help the drying-out process.[31]

There was a violent thunderstorm on May Day 1932 which caused a sudden serious flood in Bath, and led the local newspaper to produce a six-page supplement of text and photographs to cover the event. The Avon was reported to be 14ft 6ins above normal in the 'Lightning Deluge' which rose and fell quickly, producing the usual list of inconveniences, and one unusual disruption:

> 'River, stay 'way from my door', played the Bath Municipal Orchestra at the Pavilion popular concert on Monday night, but the Avon paid no heed to the plea. Nearer and nearer crept the yellow-brown waters, until they had transformed the hall into a moated palace and then invaded the floor ... There was a struggle to rescue the chairs – and the takings, which fell in an attache case into the depths until rescued by a window-pole.[32]

Another of these summer floods occurred only three years later, in June 1935, when the 'Worst Thunderstorm in Living Memory' struck the south-west of the country and caused severe dislocation to traffic in Bath.[33]

7. The Lower Bristol Road under flood water, c.1960. Note the men with the boat. (*Photograph by Rev.W.H.Parsons, reproduced by courtesy of K.Evans*)

There were more wet and cold years in the 1940s and 1950s, but the only serious flood was in 1947, with lesser disturbances in 1950 and 1959. Another inundation in 1960 tipped the scales of public opinion in favour of a determination to do something to deal with the problem. It was argued that the cost of an improvement scheme would be no more than the damage occurring to property in any one flood in Bath, and this led to a resolution to put in train the improvements in the river-flow which, by their completion in the mid-1970s, brought an end to the regular flooding of low-lying parts of the city. There have been plenty of wet winters since, such as that of 1979, which in the old days would have led to extensive flooding, but the waters have been safely confined to the river and its immediate environment. The improvement scheme has thus, to date, been a considerable success, and it is worth understanding how it works.

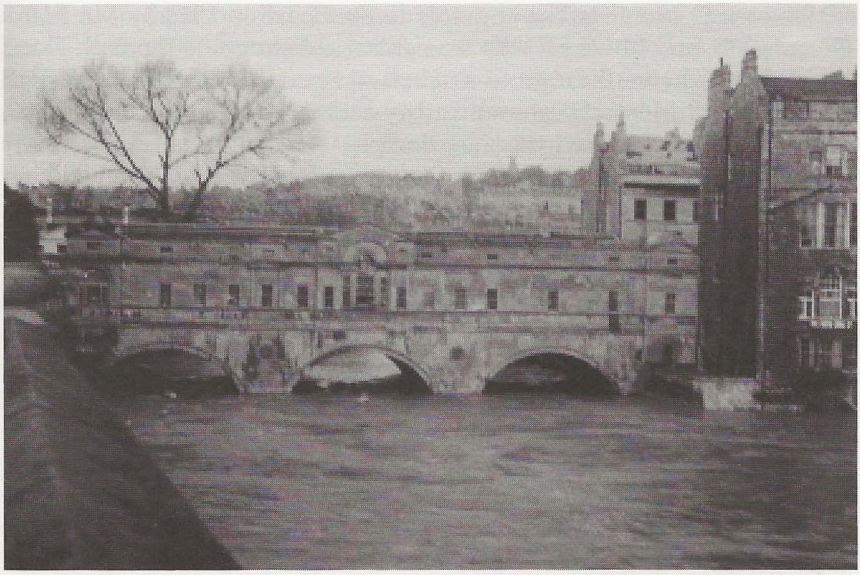
The scheme, as we have seen, was not the first to be considered. Telford had made his report in 1824 and had recommended the sort of improvements in the flow of river water which were essentially those incorporated in the modern plan. But at the time the local authority could not find the resources to adopt the plan, and it was abandoned. In 1877 a scheme based on the improvement of the existing weirs was promoted by

8. The Parade Gardens under flood water, c.1960. (*Photograph by Rev.W.H.Parsons, reproduced by courtesy of K.Evans*)

Alfred Mitchell, but not even such minimal adjustments were attempted. In 1882, the engineering consultants Messrs Coode, Son and Matthews were invited to make a report, but their recommendations for deepening the river bed and modifying the weirs, costed at £106,545, were disregarded like the previous reports.[34] In 1894, Mr.G.Remington proposed diverting flood water in the River Avon through a tunnel from Limpley Stoke to Twerton, at an estimated cost of £69,300, and this also produced no response.[35] A leading article in *Keene's Bath Journal* at the time of the flood in November that year reflected:

> The flood and nothing but the flood is still the theme of all ... If reports would bring their own cure Bath by now would be the best conditioned city to be found. We have seen how many reports have been invited upon the question of the floods yet no remedy has been attempted... it will indeed be a good day for Bath when a finish is put to the deliberations over flood prevention.[36]

Three years later a letter in the press showed how fully the principles of flood prevention in Bath had been grasped:



9. The River Avon in flood at Pulteney Bridge, c.1960. (*Photograph by Rev.W.H. Parsons, reproduced by courtesy of K.Evans*)

> Dredging, I fearlessly assert, will be one of the most important parts of any scheme of Flood Mitigation which may hereafter be adopted, and taken in connection with the control of the weirs, the removal of restrictions, including the greatest of all obstructions, the Old Bridge ... the graduation or equalization of width of the river below the city, the smoothing of the inequalities of the river banks which retard the outflow, and the construction of relief culverts are in fact all measures which ultimately must be adopted.[37]

But it was many years before realistic action was taken.

The situation began to look more promising with the Land Drainage Act of 1930, under which the River Avon (Bristol) Catchment Board was established in the following year. The first engineer to the Board was Mr. Horace Mercer, who prepared the 'Netham-Bathampton Flood Alleviation Scheme' in 1936, following the main lines of the Coode scheme of 1882 but costed at £260,000. Despite delays caused by the Second World War and its aftermath, and the cost mounting to an estimated £700,000, a start was made with improvements at Netham. As far as Bath was concerned, however, no material improvement had been made by 1960.

Mercer was succeeded as engineer to the Board in 1953 by Mr. Frank Greenhalgh, and it was he who was at last able to guide the Bath Flood Prevention Scheme through to a satisfactory conclusion.[38] Greenhalgh had modified Mercer's scheme and re-estimated the cost at £760,000. The Board had accepted this in principle, and approached the newly established Hydraulics Research Station at Wallingford in November 1953 to commission a model of the River Avon. The Director at Wallingford, Sir Claude Inglis, was sympathetic but unable to undertake the task quickly, so the Board turned to Sir Alfred Pugsley, Professor of Civil Engineering at the University of Bristol, to make a model study, and this was immediately put in hand. River modelling is based on the theory of dynamic similarity, whereby the behaviour of fluids under various configurations can be reproduced accurately on different scales. The theory was first elaborated by Professor Osborne Reynolds of Manchester, and was first applied successfully on a model of the Mersey estuary in 1893. It has become a very valuable technique for determining the best way of proceeding in order to achieve a required effect with river works, and the Pugsley team soon produced a carefully detailed plan of what needed to be done to cope with floods in the Bristol Avon.

Funding the scheme remained a problem. The Board, which had become the Wessex Water Authority, had been unwilling to finance Mercer's scheme in full, and the detailed proposals now put forward by Professor Pugsley were estimated to cost £1.4million. But the catastrophic floods of December 1960 caused damage amounting to £1.14million so that the scheme came to appear as an economy measure, and the long-suffering population of the lower-lying parts of Bath had become weary of official inaction. As Greenhalgh himself observed, 'the 1960 floods and the public feeling which they aroused changed all that, and quickly!'[39] He spelt out the options for improvement as either (i) providing an up-stream reservoir to contain impending flood water, or (ii) constructing a by-pass to carry flood water past Bath, or (iii) raising the river banks throughout the city, or (iv) deepening the existing course of the river and removing obstructions to the easy flow of water. Having dismissed the first three as impracticable for the Bath situation, Greenhalgh came down firmly in favour of the fourth option and drew up his plans accordingly. Agreement was at last reached to go ahead with this scheme, although it was necessary first to complete works at Melksham, Chippenham and Eastville which had already been approved by the Board. But in the winter of 1963-64, work began in Bath.

The first phase involved a new retaining wall at Broad Quay, and the fear that the 1960 floods had weakened the Old Bridge led to a plan for its relief and then to its complete replacement by the new Churchill Bridge and footbridge. Both were single-span concrete structures, thus removing the serious retardation of water-flow caused by the narrow five arches of the previous bridge. The services – gas and electricity mains – were carried in conduits in the new footbridge. These works were completed by May 1965. Meanwhile, channel works between Saltford and Twerton and protection works at Newbridge had been dealt with, and work had begun on the trickier tasks of replacing the old weirs and re-lining the river walls through the city with steel sheeting. The two weirs at Twerton were replaced by a modern balance-gate sluice. At Pulteney weir a new balance-gate was built on the site of the old Bathwick Mill, and a new three-step horseshoe weir was constructed to allow for the smooth passage of a greater bulk of water than the old single-step weir could accommodate. Pulteney Bridge itself was underpinned, its original timber piles being concreted. The success of the design of weir, bridge and sluice-gate was recognized with a Civic Trust Award in 1973.[40]

The final phases consisted of dredging the river through the city, and completing the various services, and these were finished in March 1974. There have been minor problems since, especially difficulties with the balance-gate sluices, but overall the scheme has been an outstanding success. The problem of flooding has been solved in Bath by improving the existing channel rather than by introducing radically new engineering works, and this arrangement has been demonstrated to be both economical and effective. But, as Frank Greenhalgh warned readers of his report, the scheme was designed to cope with any flood since 1809 and its success depends upon 'continuous maintenance of the river channel and control apparatus'.[41] It is important that the citizens of Bath should remember these limits to the effectiveness of the scheme.

Thanks to the success of the Flood Prevention Scheme, the River Avon through Bath has been able for the last twenty-five years to contain the flow of even the heaviest rainfall within its steel-shod and deepened channel. The story of the floods of Bath has thus become a matter of history, and it is to be hoped that it will remain such. But in the past complacency and inaction have led to repeated disasters, and in the future it is possible that changes in natural conditions and human management of the catchment area may re-create a situation in which floods could recur. The lesson of history, here as elsewhere, is to remain vigilant.

Notes

1 This introduction is based on personal recollection, but for details of the flood of July 1968, see J.D.Hanwell and M.D.Newsom, *The Great Storms and Floods of July 1968 on the Mendips*, Wessex Cave Club Occasional Series 1 No.2 (Wessex Cave Club, Oakhill Press, 1970); and Terry Staples, *The Great Flood of 1968* (Bristol, 1988).

2 Pictorial representation of the southward extension of buildings from the South Gate in Bath is apparent on early maps, such as John Speed's map of 1610 and that of 1694 by Joseph Gilmore: see Stephen Bird, 'The Earliest Map of Bath', *Bath History*, Vol.I (Gloucester, 1986), pp.128-149.

3 Barry Cunliffe, *Roman Bath*, No.24 in Reports of the Research Committee of the Society of Antiquaries of London (1969). Professor Cunliffe has maintained a close interest in the archaeology of Roman Bath and has updated his views in *The Book of Roman Bath* (1995).

4 Cunliffe, 1969, pp.5-6.

5 *Ibid.*; see also Cunliffe, 1995: 'it seems that throughout the third and fourth centuries the sea level had been rising and with it the general water table of the inland areas, causing a series of floods of gradually increasing severity', p.115.

6 For the thirteenth-century origin of the bridge see E.Green, 'Bath Old Bridge and the Oratory thereon', *Proceedings of Bath Natural History and Antiquarian Field Club*, Vol.7 (1893), pp.25-34.

7 R.A.Buchanan, 'The Bridges of Bath', *Bath History*, Vol.III (Gloucester, 1990), pp.1-21.

8 Rev. Richard Warner, *The History of Bath* (Bath, 1801). In the Index, printed separately, there is no entry for 'Floods', and the few entries on 'Avon, River' relate to it as a highway or a source of power. The single entry on 'Dolemeads', a frequent victim of flooding, is a botanical reference.

9 John Wood, *A Description of Bath* (3rd ed., Bath, 1765; reprinted Bath, 1969), devotes no space to any discussion of flooding.

10 See R.A.Buchanan, *op.cit.* A correction and apology is in order here, because that account fails to recognize the rebuilding in 1774 which drastically changed the appearance of Newbridge. As observed by Brenda J.Buchanan in 'The Avon Navigation and the Inland Port of Bath', *Bath History* Vol.VI (Bath, 1996), p.78 and note 33, it was the earlier bridge of the 1730s which was criticized by Wood and painted by Anthony Devis circa 1770.

11 Capt. Rowland Mainwaring, RN, *Annals of Bath from the Year 1800* ... (Bath, 1838), p.83.

12 *Bath Chronicle*, 26 Jan 1809; see also the almost identical report, in the *Edinburgh Annual Register*, 26 Jan 1809, inserted in *Bath Floods*, a large red cutting book in Bath Central Library, B551.57 BAT.

13 Mainwaring, *op.cit.*, pp.85-7. The discrepancy of £3 in the total figure is accounted for by the omission of shillings and pence from the addition.

14 *Ibid.*, pp.228-9.

15 *Ibid.*, p.483. This is Appendix No.9, listing 30 occasions between 1805 and 1834 when the citizens of Bath had raised subscriptions for charitable

purposes. The flooding of the Avon was the cause in 1809 and 1821: the other occasions included the 'Battle of Waterloo' (£3,773 for widows, orphans and wounded in 1815) and 'Distress of the Weavers in the Northern Districts'(£3,978 in 1826). Six other occasions were the result of 'Severe Weather' which could have included some flooding (1811, 1813, 1814, 1816, 1820, and 1830).

16 *Ibid.*, pp.249-50; see also *Bath Chronicle*, 6 Nov 1823.

17 *Ibid.*, pp.253-7; see also my reference to the Telford Report in R.A.Buchanan, *op.cit.*, p.5, n.6.

18 *Ibid.*, pp.297-8.

19 The Widcombe Mill was presumably that on the site of the present garage below Widcombe Manor: the mill ponds are now ornamental lakes in the grounds of the manor. See also *Bath Chronicle*, 17 Jul 1828, where it is recorded that: 'At the top of Holloway a considerable body of earth fell into the road'.

20 *Bath Chronicle*, 21 Jan 1841.

21 *Bath Chronicle*, 18 Jan 1866 and 26 Oct 1882.

22 *Record of the Great Floods in Bath*, reprinted from the *Bath Herald*,1894, consisting of 16 pages incorporating half a dozen photographs.

23 *Bath Herald*, 15 Nov 1894.

24 *Op.cit.*, note 22 above, pp.14-15: 'To such a great height had the flood risen that neither the Electric Light Company or the Gas Company thought it within the range of possibility that they would be enabled to continue their supply'. In the event, the electricity supply was maintained, but 'the gas supply was cut short entirely'. Recalling the incident many years later, this was attributed to a barge hitting the pipe across the river at the gas works, allowing the mains to become flooded – see *Bath Chronicle*, 3 Jan 1925.

25 The flood marks on the south abutment are clearly visible from the river-side footpath: some are worn or partially obliterated, but that for 1894 stands clearly above the others.

26 *Bath Chronicle*, 18 Jun 1903: 'Flood in Bath'; also 3 Jan 1901.

27 *Bath and Wilts Chronicle*, 21 Jan 1918: 'The Avon in Flood'. In 1894 it had been reported that 'it is a superstitious belief of old Avon watermen and "bargees" that a quick falling flood will soon be followed by another, but a slow dropping means that this is to be the last of the series': *Bath Herald*, 15 Nov 1894, p.8.

28 *Bath and Wilts Chronicle*, 21 Jan 1918: cutting in small white bound book in Bath Central Library, B551-57 BAT.

29 *Bath Herald*, 3 Jan 1925.

30 The donation of Mayor Chivers is recorded in *Bath Chronicle*, 3 Jan 1925.

31 Bath Record Office (BRO): 'Funds, Subscriptions, Presentations, Etc' Box 9, Bundle 102 – 'Flood Relief'. Each flood is covered by a collection of about ten subscription books and accounts of varying degrees of completion. About £200 was raised in 1881; £2,328 in 1882; £279 in 1885; £302 in 1889; and £634 in 1901.

32 *Bath Herald*, 3 May 1932: 'Bath's Very High Tide'.

33 *Bath and Wilts Chronicle & Herald*, 26 Jun 1935 (complete copy filed in Bath Central Library, B551.554 BAT/A 606582).

34 Frank Greenhalgh, *Bath Flood Prevention Scheme* (Wessex Water Authority, 1974), Bath Central Library at B627.4, Chap.1 'Historical Background'.
35 Geo. Remington, *Mitigation of Floods – Bath*, 17 Nov 1896. Proposal for a culvert 4 miles 7 furlongs from Limpley Stoke to Twerton, with report and maps: in BRO.
36 *Keene's Bath Journal*, 24 Nov 1894: 'The Floods of Bath'.
37 The printed letter, from Jas. Baster of Beechen Cliff, is in the 'Funds, Subscriptions, Presentations, etc', Box 9, Bundle 102, packet 9: in BRO.
38 This summary of the Flood Prevention Scheme is based on Greenhalgh, *op.cit.* It is a well illustrated book in landscape format, 44pp.
39 *Ibid.*, p.12.
40 Bath Flood Defence Scheme, National Rivers Authority, pamphlet, n.d.
41 Greenhalgh, *op.cit.*, p.43.

ACKNOWLEDGMENTS

The author would like to thank the Librarian and staff of Bath Central Library; the Bath City Archivist Mr. Colin Johnston; and others who have assisted in his enquiries. He is grateful to Mr. Ken Evans for making readily available the dramatic photographs of some of the last Bath floods taken by the late Rev. W.H.Parsons of Widcombe Baptist Church, and to Hilary Strickland for her assistance with the map and diagram. And he would also like to thank the Editor for encouraging him to persevere in the study of this subject, and for her valiant editorial efforts on it.