Gara River: An Early Hydro-Electric Scheme in Northern New South Wales

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This paper describes one of Australia's earliest hydro-electric schemes, completed in early 1895 at Hillgrove, near Armidale, New South Wales. The scheme operated for only a short time before being closed down, and was not reopened until 1900. The closure of the initial scheme was due to drought, the downturn in mining at Hillgrove, and the economic crises of the mid 1890s. Both the archaeological remains and the historical record reveal that at the time none of these was considered to be a major cause of the failure of the scheme. The paper proposes that this was due to the novelty and allure of electricity, which was enough for both designers and investors to ignore what was happening around them. If so, the role played by perception has to be seen as a major factor in the success or failure of such economic activities. The examination of the Gara River hydro-electric scheme shows that issues such as the role of perception are valid within the study of historical archaeology.

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INTRODUCTION

The late nineteenth century saw the introduction of electricity to Australia for domestic and industrial consumers. The impact of its introduction was diminished by the economic collapse of the 1890s, but other factors were also important in influencing how it was adopted.

This study examines the establishment and subsequent history of one electrical scheme in the 1890s. The Gara River was dammed for the production of hydro-electricity for the town and mines of Hillgrove, east of Armidale, New South Wales (Fig. 1). It was one of a number of similar ventures being proposed in New South Wales and Tasmania at the time. The scheme failed soon after it began operation in 1895 but was able to be reactivated with slightly better results in 1900. The collapse of the scheme was partly due to the depression but other factors, including overly optimistic expectations of electric technology and a misunderstanding of the environment, contributed to its failure.

The historical and archaeological study of the Gara River hydro-electric scheme permits the detailed study of the factors involved in the failure of the scheme and of how solutions were found for these problems. It also highlights the lack of understanding of factors which may have been critical to the success of such ventures and helps to explain the perceptions of the people involved in the scheme.

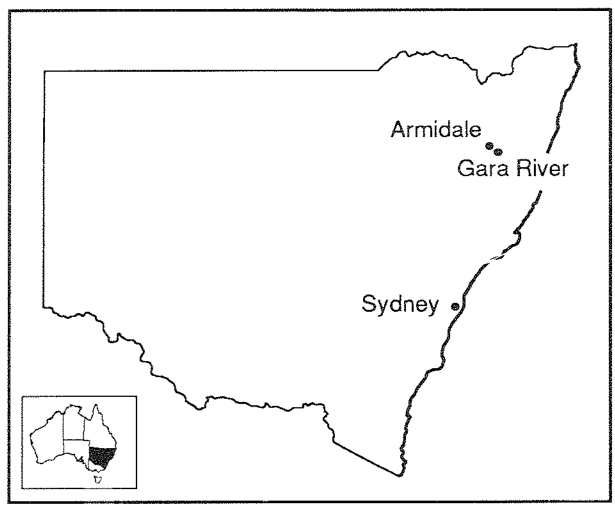

Fig. 1: Location of the Gara River, northern New South Wales.

HISTORY AND DEVELOPMENT

1. Early hydro-electric schemes

The first hydro-electric scheme in the world began operation in Godalming, England, in 1881.[1] It was a very simple affair which allowed a small dynamo to run lights in the town.

The growth of hydro-electricity could only take place after the development of the Pelton wheel and the incandescent light-bulb.[2] The Pelton wheel harnessed the kinetic energy of falling water, so that it could be used to drive a dynamo which would be able to generate electricity. The incandescent light provided a practical use for the power that was generated. Both of these inventions had been introduced and refined in the late 1870s.[3]

Hydro-electric technology complemented rather than replaced existing steam, gas and water power. Steam-driven electrical dynamos gained greater acceptance because of their mobility, versatility and cheapness, but helped to create a demand for electricity generation of all types. Hydro-electricity was adopted rapidly around the world after its introduction at Godalming, schemes being established in the United States in 1882, New Zealand in 1885, Australia in 1888 and Japan by 1890.[4]

2. Hydro-electric power in Australia

Hydro-electricity reached Australia within seven years of its first use in England. The earliest reference to it appears to be a proposal by the City Council of Launceston in 1887 to investigate the possibility of its use in the South Esk River.[5] A year later the owner of the nearby Waverley Woollen Mill installed the first operational hydro-electric plant in Australia.[6] The owner, Mr Hogarth, had examined mills powered by hydro-electricity in Scotland and returned with suitable machinery for his Tasmanian mill.

Also in 1888 Tamworth, in New South Wales, became the first town in Australia to be lit by electricity[7] and its presence soon became a synonym for civilization. While the use of electricity became increasingly widespread, hydro-electric power was still not being widely adopted. The Jenolan Caves were lit by a small plant, which replaced a steam plant.[8] Launceston was still examining the hydro question, while suggestions were made to change from hydraulic to hydro-electric power generation at the mines of Zeehan and Dundas, in Tasmania.[9]

The major reason for the lack of popularity of hydro-electricity was that most potential users (towns, industries and mines) were not located near areas suitable for hydro-electric plants to operate. There was considerable existing investment in steam-generated electricity and where water was available it was often already being harnessed for hydraulic power.

The first substantial venture into hydro-electricity in Australia was the formation of the Australasian Rights Purchase Association, a group of mainly Victorian investors who would fund the development of commercial hydro-electric schemes as entrepreneurs, by identifying suitable and economically viable locations for hydro schemes and developing plants for the commercial sale of power to industry or domestic users.[10]

The first venture of the Association was to obtain water rights and install generating plant at Zeehan, Tasmania, for the mining works.[11] The development of the scheme began in late 1891 or early 1892. It was never completed, largely due to the closure of the mines during the economic collapse and the failure of critical investment to materialize. The same Association came before the New South Wales Parliament in 1892, as the New South Wales Electric Supply Company, to propose a hydro-electric scheme on the Colo and Grose Rivers to supply power to Sydney.[12]

The next scheme, and the first brought to fruition, was at the Gara River in 1895. After this, the next working scheme was only built in 1906 at the Styx River to the east of Hillgrove.[13] In 1910 the Tasmanian Great Lakes Scheme began, heralding the start of state-funded hydro-electricity schemes. From this time the role of private hydro-electricity schemes quickly diminished, as electricity generation became a responsibility of the state.

3. Hillgrove and the Gara River hydro-electric scheme

The town of Hillgrove owed its existence to the presence of gold and antimony. Mining began in 1877,[14] and the town grew to a peak of over three thousand inhabitants within twenty years.[15] The rugged gorges at the edge of the New England tableland required a heavy investment in power for the mining operations to light the mines, carry men and ore up the sheer sides of the gorges and to operate the processing machinery. The steam engines which were used consumed large quantities of water and timber as fuel.[16] The residents of Hillgrove had constant problems with getting adequate access to water supplies monopolized by the mining companies.[17]

The first mention of a hydro-electric scheme for Hillgrove was when the Hillgrove and Armidale Water-Power Electrical Company lodged a memorandum of agreement with the Registrar of Joint Stock Companies in July 1892.[18] By early October a petition for a bill was placed before the New South Wales Parliament, requesting an act of Parliament to enable the water rights of the Gara River to be exploited for the purpose of power generation.[19] Among the proponents were several who had been involved with the Australasian Rights Purchase Association.[20] It is likely that the Hillgrove and Armidale Water-Power Electrical Company was another company formed by the Australasian Rights Purchase Association, to develop and implement a hydro-electric power scheme.

The Bill was passed on 10 March 1893.[21] Later that year the consultant electrical engineer, Professor Richard Threlfall of the University of Sydney, made his first visit to the Gara River.[22] As well as being involved in the design and construction of the scheme, he even allowed himself to be enrolled as mortgagee for the company, which was to have important consequences later on.

The land chosen for the scheme, on the Gara River where it begins its cut into the edge of the tableland, was about 7 km from the first of the Hillgrove mines. While a closer location would have been better for electrical distribution, the water rights had already been taken up.[23] A dam would gather the water of the Gara River at the Blue Hole and a weir would regulate its flow into a flume which would carry it for about 2.5 km to the power station site at the Gara or Great Falls. The route chosen combined easy access for construction and the greatest possible drop, and consequently power, over a short distance. Construction proceeded through 1894[24] and the plant was ready by late February 1895. When the lights of Hillgrove were turned on, it became the first town in Australia to be lit by hydro-electricity, beating Launceston, which often makes the claim, by nearly ten months.[25]

Despite the fanfare and accolades of the opening, all was not well with the scheme. By early March Threlfall was already suggesting that a new flume was needed.[26] The flume, for all its engineering skill, was basically very fragile. Any leakage or drop in the levels would cut the water flow to the generator, as also would a drought. The Gara River is not very large and the dam was quite small. As rainfall records show (Fig. 2), 1895 was not a good year to be pinning faith on water resources.

Money as well as water was drying up. Threlfall mentioned money problems in late March 1895.[27] The worsening economy would have made the operation of a purely speculative venture extremely risky, especially as estimates of revenue would have been calculated at the height of the antimony boom. By 2 May he was

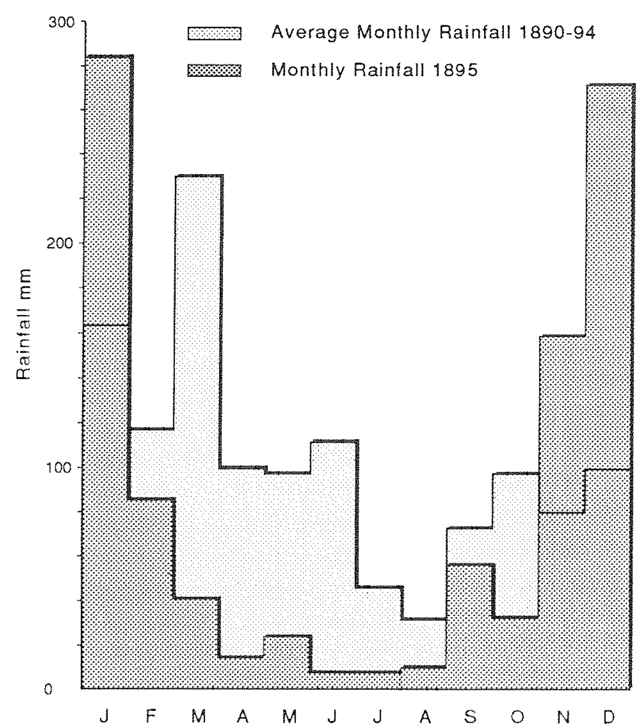

Fig. 2: Average monthly rainfall figures for Hillgrove 1890–94 compared to 1895. (From Bureau of Meteorology figures for Hillgrove.)

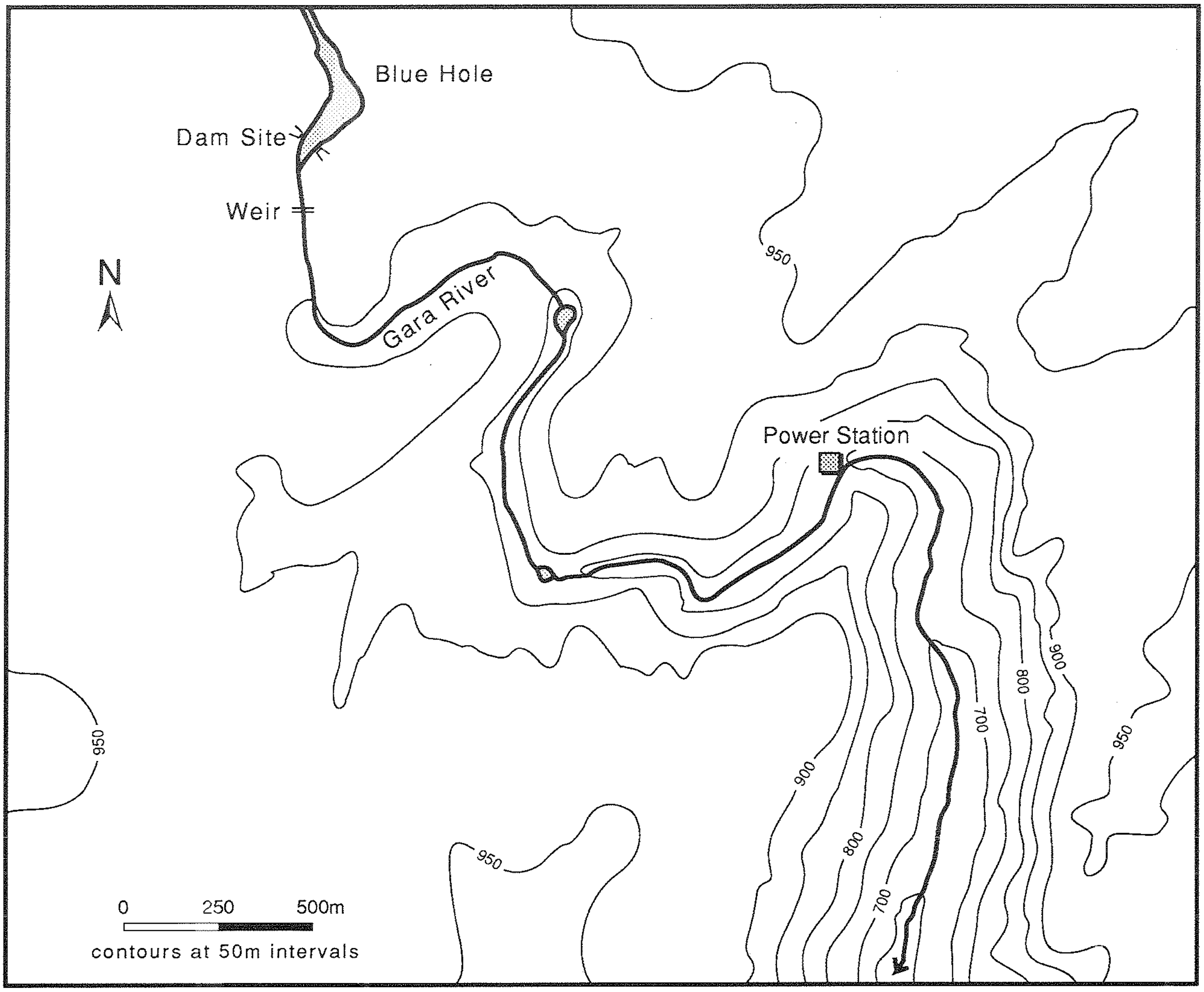

Fig. 3: Topography of the Gara River. (Adapted from C.M.A. 1:25,000 map, Hillgrove 9236–I–N.)

forced as mortgagee to take possession of the company[28] and in mid June the company was liquidated.[29] Following this disaster a succession of small companies took over ownership of the scheme,[30] but it is not clear whether they were able to maintain the supply of electricity to the town or mines.

Renewed interest in the works came in 1899. The *Hillgrove Guardian* reported that the Sandon County Electric Light and Power Company had been constructing and repairing the old works and by December the dam had been completed.[31] Regular articles expressed nothing but a brave optimism that, this time, it would all go according to plan. The reasons given for the failure of the original scheme were certainly correct in part. The inadequacy of the dam, the flimsy flume and the lack of protection for the power station site from landslides and falling rocks were all contributing factors.[32] The articles did not mention economic decline, over-optimistic expectations or the short, sharp droughts. Hillgrove had survived the end of the antimony boom in the mid 1890s because it could still mine for gold, and for the past few years the rainfall had improved.

In charge of the works was Frank Cotton M.P.[33] The reason for his involvement is unclear. He is not known as an engineer or manager.[34] As a Member of the Legislative Assembly he had sat on both the select committee studying the Colo-Grose scheme and the one examining the Gara River proposal.[35] The possibility exists that he recognised the opportunities presented by these schemes and was able in the late 1890s to mobilize investment in the revival of the Gara River scheme. He also produced a prospectus for a scheme on the Colo and Grose Rivers.[36]

The lights of Hillgrove were switched on in the evening of 1 April 1900.[37] As before, speeches were made and toasts were drunk to this sign of encroaching civilisation. But, as before, there were reasons against being optimistic. The town had gone into a slow decline, with the price of antimony about to drop even further than it had in 1895.[38] The reasons identified by the newspapers for the failure of the first scheme had, in theory, been rectified. The underlying causes of failure had not been recognised and it is clear that the new works must be considered to have been ultimately only a cosmetic solution.

The ownership of the scheme changed again in July 1900.[39] By 1905 the plant was being leased or operated by a Mr Pinto, who sold the power to local users.[40] He operated at least until 1907,[41] the last time that the Gara River hydro-electric scheme is mentioned as a functioning enterprise. From about that time Hillgrove's fortunes began a rapid decline from which it never recovered.

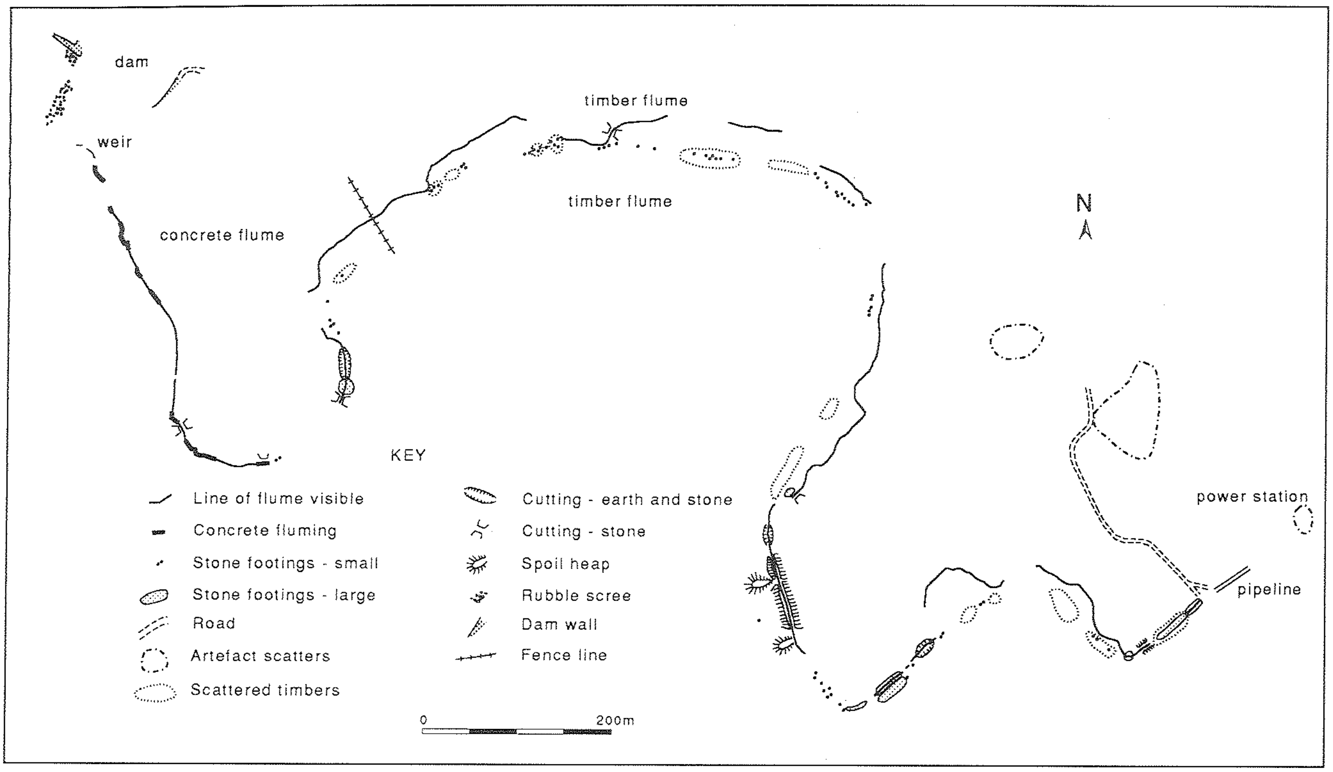

Fig. 4: Archaeological remains identified at the Gara River.

ARCHAEOLOGICAL EVIDENCE

1. The survey

The historical and archaeological research at the Gara River was conducted as part of a conservation plan for the National Parks and Wildlife Service of New South Wales.[42] The aims of the archaeological survey were to identify and record surviving fabric from the hydro-electric scheme, to establish its cultural significance, and to formulate policies for its conservation.

2. Setting

The Gara River is a small tributary of the Macleay River which runs to the east of Armidale. At the Blue Hole, a natural pool on the edge of the tableland, the river begins its descent into the Macleay-Apsley gorge system (Fig. 3). The first set of falls is known as the Great or Gara Falls and was reserved for its scenic beauty in 1880.[43] The land on which the remains are located is now part of the Oxley Wild Rivers National Park. Vegetation consists of light eucalypt woodland with little undergrowth. However, part of the river is choked with blackberry and other weeds.

3. Physical remains

The remains of the hydro-electric scheme can be divided into three functional units: the dam and weir, the fluming, and the power station. The archaeological evidence relates to the two phases of construction identified previously. Initial construction began in 1894 and the scheme was opened in 1895, and the second phase consisted of construction in 1899 and 1900. Both phases are discussed under each heading below. The location of archaeological remains is shown in Figure 4.

i. The dam site. The dam was erected at the southern end of the Blue Hole. The remains consist of the two ends of the dam wall and a granite boulder scree. The dam is of crib construction, with a framework of large timbers packed with small boulders and earth. Remains of the cribwork can be seen at the end of the western section of the dam wall. The remains of a road are evident on the top of the eastern section. The central part of the dam wall has not survived and the boulder scree immediately downstream represents the remains of its packing material.

A photograph (Fig. 5) shows the dam under construction, although it is uncertain whether this shows the first dam or its later repair. From the historical documents it is not possible to reconstruct the history of the dam. It can only be inferred that the first dam wall was not high enough, as the newspaper accounts mention this several times. It could be read either that it was not able to store enough water to see through a drought or that it could not deal with flash floods. The *Hillgrove Guardian* in October 1899 described the second dam as '...60 ft [18 m] across and built up to a height of 30 ft [9 m]'.[44] The surviving archaeological evidence does not reveal whether the original dam wall was incorporated into the later wall construction.

Approximately 100 m downstream from the dam is the weir. This is a low concrete wall in two sections, set in one of the narrowest parts of the river. It is still intact and in good condition, and it bears no evidence of repair, alteration or redesign.

The weir was built as part of the original scheme. Its purpose was to divert water from the river into the fluming, which would carry it to the power station. The level of the weir acted as a simple regulator of the water flow in the system. If the weir was too high an excessive amount of water would be taken to the power station, possibly beyond the capacity of the generators. If the weir was too low insufficient water would be provided for the generators, leaving them unable to operate. The incorporation of the weir into the second scheme, without apparent alteration, indicates that the capacity of the power station was not substantially changed at that time.

ii. The fluming. Connected to the weir and running for approximately 400 m is a V-sectioned concrete channel or flume. This leads south from the weir and takes the water around the first main spur of the gorge. The concrete flume is largely filled in with slopewash and overgrown with blackberry, but the line appears to be substantially intact.

The fluming carried the water from the river to the top of the power station site. Its purpose was to ensure that the water travelled at a constant velocity. For this reason the flume needed to be precisely levelled to specific gradients suitable both to the topography and to the capacity of the station.

The concrete fluming was constructed as part of the original scheme and was incorporated into the rebuilt second scheme. From the visible remains, there is no evidence of repair or alteration of the design or its layout. The line passes through a stone cutting, indicating the importance of maintaining an exact level.

The southern end of the concrete flume goes around a rocky spur, where the ground level drops quickly. The concrete flume terminates and there is a gap of over 80 m before its line can be picked up again. The only evidence of its route is two stone footings. The route is next evident at a stone cutting, which is followed by a large stone footing and then a further cutting through stone and earth. Once through the latter cutting two separate lines are found. The first consists of a series of small stone footings, with occasional scatters of long timbers. The second is a clearly visible line which follows the contours of the top of the valley.

The first line can be defined by joining the stone footings. These are piles of roughly shaped stones constructed into platforms or pads (Fig. 6). Their size varies greatly but the majority are less than a metre square. Some of the footings consist of long beds of stone, rather than separate piles. The footings have suffered various degrees of collapse, but as they are *in situ* it is possible to reconstruct the route that they formed. The line runs across the gullies from spur to spur in a series of generally straight lines. The route has been located so as to use the smallest number of straight line segments.

Spread out along the line of the first flume are scatters of timber. These consist of long, slender debarked logs, frequently with bolts, nails or pieces of wood attached to them. Also possibly related to this flume line are isolated finds such as sections of milled timber, pieces of flat galvanised iron with nail holes around the perimeter and other pieces of metal. The purpose of these is difficult to determine as none of them are *in situ*, and they cannot be definitely associated with either flume.

The length of the first flume line, from the end of the concrete flume to the pipe head at the power station site, is approximately 2100 m. Some parts of the route are conjectural, as no footings or other evidence has survived. Apart from one instance, the route does not go through any cuttings until the pipe head is reached. In that one instance, evidence could have been missed of the route going around the spur.

The second flume line is of a completely different form. The line can be traced as a path about 1 m across, which maintains an almost exact horizontal level as it follows the contour of the side of the valley. As with the other flume, there are no *in situ* remains of any trestles or fluming. The line is nearly continuous from where the two flume lines diverge to the pipe head. The only gaps are where it crosses gullies (although no evidence survives as to what form of crossing was constructed), and near the end of the line, where it had to circle around a rocky spur. In this latter area there is evidence of stone footings, which may relate to either or both of the flume lines.

The second flume line goes through several cuttings, including one series which is nearly 100 m long. These cuttings are in locations

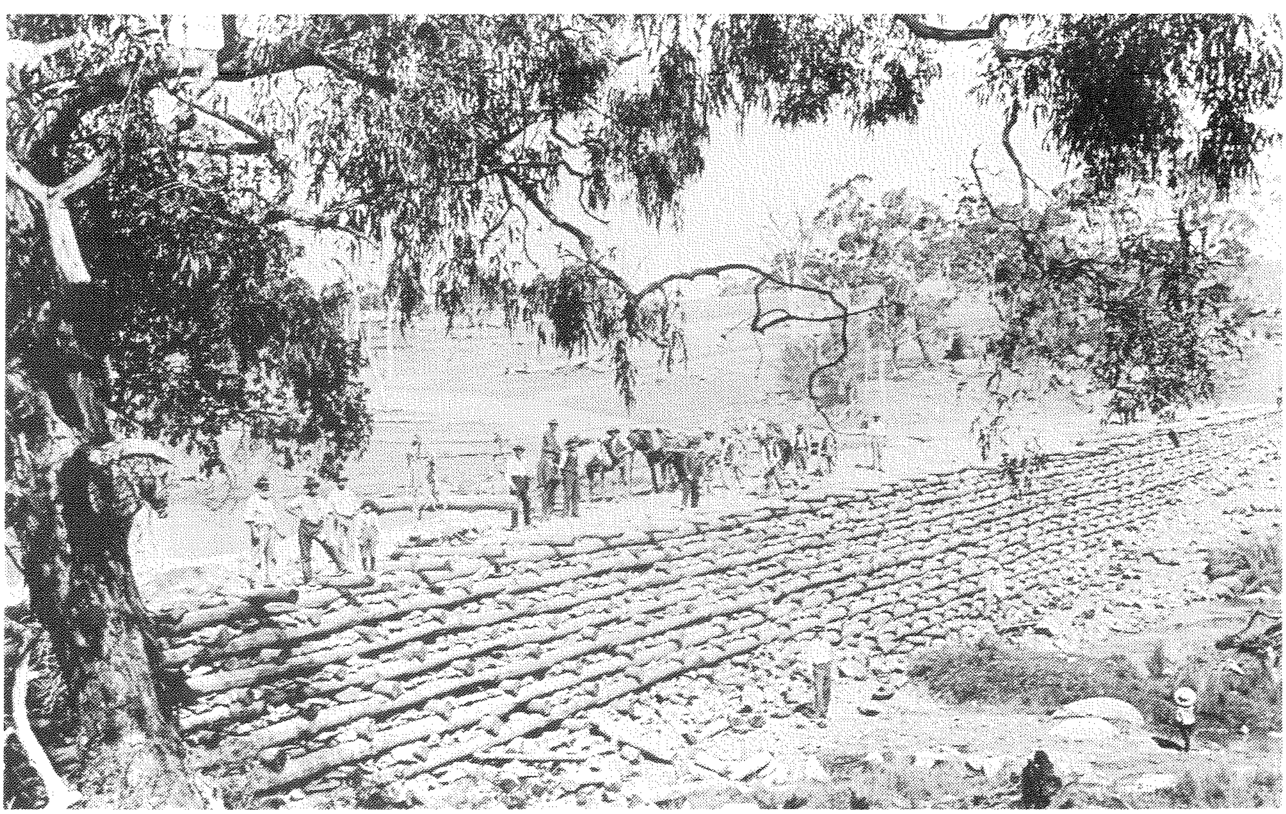

Fig. 5: Dam under construction across the Gara River at the Blue Hole. Undated. (University of New England Archives.)

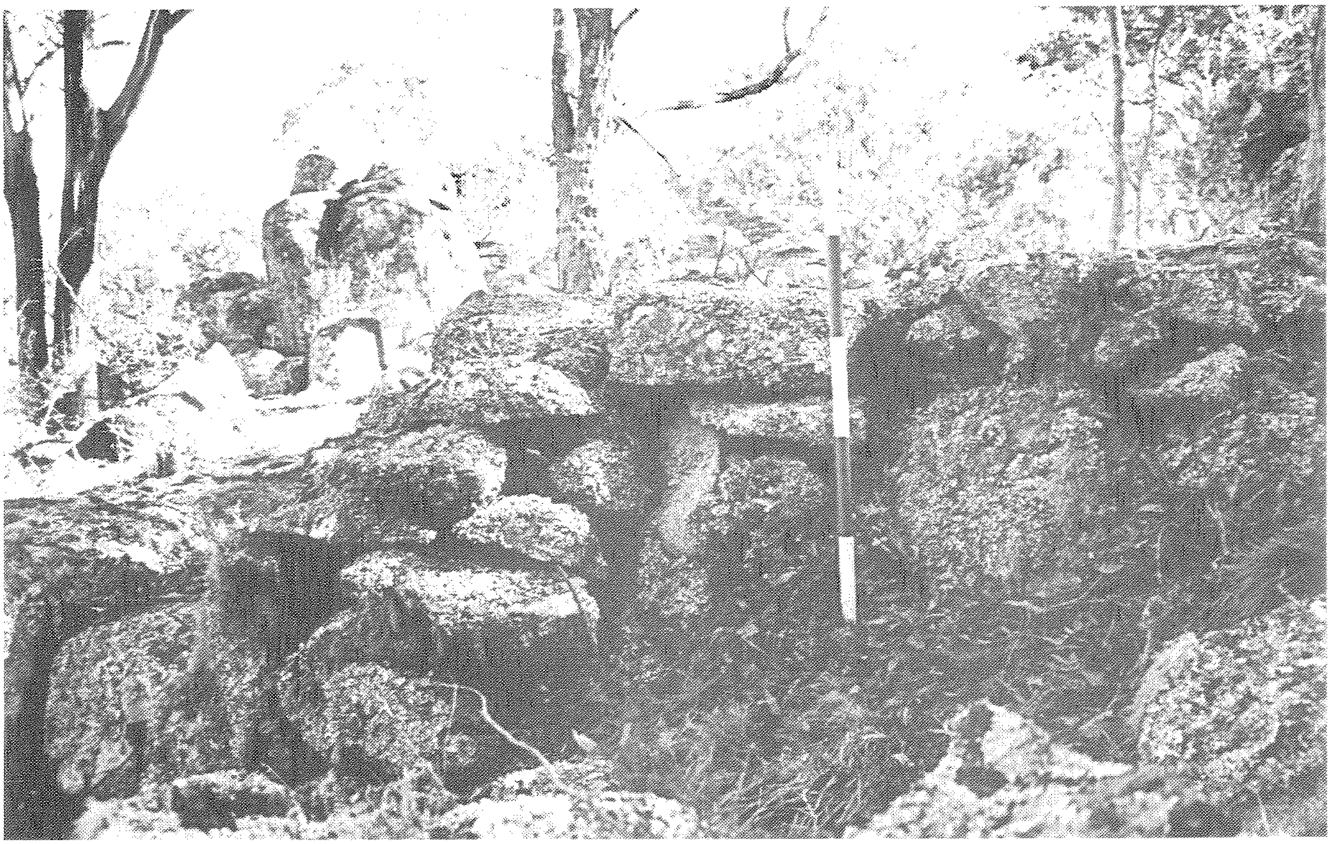

Fig. 6: Stone footings for flume. Scale in 200 mm segments. (Photograph by Grisoula Giopoulos.)

which enable the route to avoid rocky and uneven areas. The line of the flume is extremely sinuous and takes many sharp turns in its path. Where possible it avoids areas which require trestling of any substantial height or distance. The total length of the second flume line is about 2350 m, 250 m longer than the first flume line, largely because of its sinuous route.

The identification and phasing of the two flume lines creates conflicts between the historical and archaeological evidence. The identification of the first line as a flume is relatively straightforward. The stone footings represent the supports for the flume, which rested upon a trestle system spanning the gullies. The scatters of timber are the only surviving remains of the trestles. The second line shows no evidence of having been supported on trestles, except where it rounds the last spur and there the evidence is ambiguous. Neither is there any evidence of how it spanned the gullies, stone footings being entirely absent. The identification of it as a flume rests upon the design, which is of an almost perfectly level track, passing through large cuttings and terminating at the pipe head.

The archaeological phasing of these two lines depends upon the assumption that the flumes would use any available shortcut to reduce the length of the route. The first (trestle) line goes around the spurs which were subsequently cut through by the second line. It is unlikely that the flume would have been directed around the outside of the spurs if the cuttings had already been made. It is logical, therefore, to argue that the first phase of fluming, built in 1894–95, took up at the end of the concrete flume, going through a stone cutting and possibly the larger earth cutting. It then continued along its route raised on trestles, going from spur to spur, until it reached the pipe head at the power station. The second flume line was then constructed on a completely different design. To reduce the problem of the flimsy flume (more likely the flimsy trestle), the flume was now brought as close to the ground as possible. The requirements of a consistent and even gradient still applied, which is why the route almost follows a single contour. Cuttings were made to reduce the need for trestling around spurs. Where gullies had to be crossed, small trestles or single-span bridges may have carried the flume across. An alternative phasing, with the longer route being constructed first, is possible but, if so, why would the trestle line completely avoid the cuttings, which would have shortened the route considerably and reduced the problems of building around the spurs?

The *Hillgrove Guardian*, however, described the second set of fluming erected in 1900 as:

> ...of a very substantial nature throughout, as it would need to be, the perpendicular height in one part being 43 ft [13 m] and is estimated to average 25 ft [7.6 m] in the whole length. The fluming is all made of $1^1/_2$ in. [38 mm] Oregon pine, all grooved, the tonguing being fitted in as tightly as if the whole were one piece, 4 ft [1.2 m] wide by 2 ft [0.6 m] high.[45]

This very exact description goes against the model proposed on the archaeological evidence alone. Two different interpretations are possible. Either the flume built in 1895 was removed and replaced by the one described above in 1900, and later a third rebuilding, documented nowhere, of the flume resulted in the second line, or the original 1895 flume was the route with the cuttings, and the 1900 flume, for whatever reason, chose to avoid the cuttings. In the absence of other archaeological data or historical information, it is not possible to choose between these two interpretations or to reject the archaeological model presented above.

iii. The power station. The remains of the power station consist of the route of the piping and fragments of machinery and structures. The power station was located at the base of a steep cliff at the Gara Falls. The flume terminated at the top of the cliff and discharged water into the pipes or penstocks, which took it down about 120 m to the dynamos at the power station.

The remains of the power station are covered in weeds, and soil and rocks from the cliff but fragments of machinery and concrete footings can be seen. The area appears to have been considerably disturbed at some time in the past, possibly during salvage of the equipment. It is not possible to reconstruct adequately the layout of the power station site from the visible remains. Some of the machinery is recognisable as commutators and axles from the dynamos. Two manufacturers' plates have been recovered, one from the Westinghouse Electric and Engineering Company, and the other, with part missing, from a '...X VICTORIA TRANSFORMER PATENT 2721'.

The power station was described in 1899 as '... one of the finest electrical plants in Australia with four pelton wheels and motors capable of supplying up to 1000 h.p...'[46] and:

> The inside of the shed now presents quite a transformed appearance. The motors have been restored to their original positions and solid foundations, and the whole of the shed has been newly floored with $1^1/_2$ in [38 mm] Oregon pine. All of the machinery has been cleaned up and everything put in exhibition order...[47]

Above the power station the channel where the upper part of the pipes were laid is clearly visible. It is about 5 m wide and up to 1.5 m deep. The pipes have been removed, the only features *in situ* being ring-bolts let into the rock. No evidence remains of the series of netting screens which were erected at intervals down the slope to prevent rocks falling on the power station.[48] However, the power station site does have evidence of the substantial timber framing that was erected to protect the building from landslides. From the account of the *Hillgrove Guardian* this must have been a matter of great concern, and one which would have stopped the station at times.[49]

iv. Other features. The only other features which are likely to date from the period of the hydro-electric scheme are a house site near the pipe head and several scatters of artefacts, including one almost solely composed of shims used when joining large-diameter pipes.

No part of the area occupied by archaeological traces of the hydro-electric scheme was developed for any other purpose after the abandonment of the scheme.

DISCUSSION

The Gara River hydro-electric scheme can be used to examine a number of issues pertinent to industrial archaeology and economic history. These include the design and development of early hydro-electric schemes, the industrial history of the 1890s depression, and the interplay between perception and economic change.

When it first began operation in March 1895, the Gara River scheme was the most highly developed hydro-electric scheme in Australia, and one of the most innovative in the world.[50] It is one of the positive aspects of the Australasian Rights Purchase Association that they were able to create such a plant. The approach which they adopted in selecting the location was equally well thought out. The topography of Hillgrove was suitable for the harnessing of water for hydro-electric power. There were a number of separate mining concerns which were potential customers and the mines had been established long enough to have depleted the local sources of timber, making the cost of hydro-electricity relatively cheap and attractive.[51] In addition, Hillgrove was in the middle of an antimony boom, which appeared to guarantee the future of the town and its mines. In theory, Hillgrove offered the ideal choice of a market for an independent electricity generating company to serve.

That optimism was quickly undercut by several events. The depression had struck the economy by 1895, drying up sources of capital investment which would have been required by the company to ensure it could pay its staff and meet outstanding debts. The market in antimony also collapsed in 1895. Antimony is a boom-time mineral, its price at other times seldom justifies its extraction.[52] While Hillgrove still had gold, this could not ensure that it could remain viable, although it did mean that the mines could continue operating.

Commentary on the failure of the first Gara River hydro-electric scheme stated:

> ...there were three distinct failures in connection with this important scheme; first, the inadequate conservation of water; second, the flimsy character of the fluming intended to conduct the water from the head of the Falls to the Power Works, and lastly, the incompleteness of the protection to the machinery at the Power Works...[53]

These complaints, while certainly correct, do not focus on the real reasons for the failure of the scheme in 1895. These are evident in the fortunes of the second phase of the scheme. Although the complaints had been remedied, the underlying causes of failure were not addressed.

The archaeological record shows clearly that one of the main failures of the first scheme was seen to be the flume. Almost the entire length of fluming was replaced for the second scheme, as a major investment of capital. The adoption of a completely redesigned and built flume, with substantial trestles, signified more than a new engineering solution, it affirmed that the scheme could now become a success. There would be no point in adopting such an expensive solution, if the designers of the scheme were not convinced that it would solve all of their problems. The problems, however, were not so easy to solve. Hillgrove's economic viability had been undermined by the end of the antimony boom. While the price recovered slightly after 1896, it could no longer ensure continued productivity.

The economic depression generally reduced the level of secure investment in speculative enterprises such as hydro-electric schemes. If investment was cut back, how was the Sandon County Electric Light and Power Company able to raise the capital to undertake its works? While the company documents have not been located, it is certain that the presence of a prominent figure such as Frank Cotton M.P. was a reassuring factor for potential investors. The only plausible explanation for the achievement of the necessary scale of investment would be that, like the newspapers, the investors believed that the failure of the first scheme was due to design errors, rather than to the collapse of the economy that the scheme depended upon. Cotton knew of the Gara River and Colo-Grose schemes almost from their inception. He was aware of the people who designed and developed the Gara River scheme. The reasons the scheme failed should have been evident. At the same time, the depression would have been causing many different types of enterprise to fail. 'Design error' could not be invoked as an explanation for all of them.

The answer would appear to be in the allure of electricity. As stated earlier, electricity was the invention of the age. From the lighting of Tamworth to the electrification of Sydney, it was seen as a new force capable of creating wealth and prosperity to those who possessed it. The glamour of electricity must have been sufficient inducement to be able to part investors from their money. Simply supplying Hillgrove with electricity would be a trigger for industry to take off with renewed vigour. If that argument sounds far-fetched, remember that it is still the main justification for the construction of hydro-electric schemes in Tasmania.[54]

As with the changes to the flume, the enlargement of the dam appears to have been ineffectual. Threlfall's measurements of river flow were made in wet years and when the dam was erected it took only a few months of drought to threaten the scheme. The Sandon County Electric Light and Power Company increased the height of the dam and its capacity, but they were restricted by the physical limits of the Blue Hole. Increasing the dam to any height would still have resulted in a broad, shallow body of water which would have suffered a relatively high evaporation rate in relation to its volume. The short drought of 1895 could easily have gone on for longer. However, the main concern of the contemporary newspapers was that the dam should be able to survive flash flooding. Yet in all these matters, the emphasis of the Company was on modifying the design, without recognising the real reasons for the failure of the scheme.

CONCLUSIONS

The understanding of an enterprise such as the Gara River hydro-electric scheme should go beyond the examination of the historical documents of the place and attempting to match these with the surviving fabric. While this process checks the veracity of the written record, it does not do justice to the archaeological resource. This still remains largely mute, being only understood as a collection of features which do or do not match the written history, with token discussion as to why this is so. Such an approach reflects an inability to handle the physical fabric as a document in its own right.

The value of sites such as Gara River is not only that they inform us about extinct technologies, but also that they record parts of broader processes, whether social, economic or technological. This has been accepted by heritage conservation practitioners,[55] but has not been taken up by industrial archaeologists.[56]

Examination of the Gara River hydro-electric scheme has shown that the failure of enterprises in the 1890s depression can be a complex network of factors, from the national economy to local rainfall. In sorting out the relative importance of these, it is essential to understand the roles played by the people on the spot. Their perceptions of what was happening, were what they based their actions upon. Perception can be quite different to 'reality' (i.e. hindsight) and it is important in interpreting change to give proper weight to the influence of what people *thought* was happening. The role that perception played at Gara River is clear. Broader economic reasons for the failure of the first hydro-electric scheme were ignored, a belief in the soundness of the scheme and in electricity persuaded investors to back it for a second time. The faith that the investors and designers of the second scheme had is evident in the archaeological record, which tells how they thought failure could be averted.

What lessons can we draw from the Gara River hydro-electric scheme that are pertinent to industrial archaeology? The archaeological record embodies information on social, economic and technological process beyond what may be immediately apparent in the fabric of the site. Access to this information requires a broader approach than is currently being practised in industrial archaeology. While historical questions can be tested on archaeological data, the archaeological data themselves suggest different questions for investigation. Understanding the Gara River hydro-electric scheme, required that the archaeological evidence be recognised as the product of perception as much as of action. The historical record presented a clear picture of the failure of the schemes. The archaeological data suggested ways of understanding that evidence, which involved identifying what people thought, as well as what they did.

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NOTES

1. Tucker 1977.
2. ibid.
3. ibid.
4. For United States, see Schools Council 1975: 92. For New Zealand, see Thornton 1982. For Japan, see Uchida 1984.
5. Kozakiewicz 1982.
6. Green 1959.
7. Davison et al. 1987: 86.
8. Leigh 1894; Trickett 1922: 33.
9. Dallas 1960: 90.
10. New South Wales Legislative Assembly 1892–93a.
11. ibid.
12. ibid.
13. Mainwaring 1986b: 6.
14. Neale et al. 1981; Mainwaring 1986a, 1986b; Baker 1971.
15. Neale et al. 1981.
16. New South Wales Legislative Assembly 1892–93b.
17. Neale et al. 1981; *I.S.N.* 28/11/1889.
18. A.O.N.S.W. 3/5714.
19. *N.S.W.G.G.* 1893, 2: 357–71.
20. New South Wales Legislative Assembly 1892–93a; New South Wales Legislative Assembly 1892–93b.
21. ibid.
22. Threlfall 1894–97.
23. New South Wales Legislative Assembly 1892–93b.
24. Threlfall 1894–97.
25. Kozakiewicz 1982.
26. Threlfall 1894–97: 238.
27. ibid.: 268.
28. ibid.: 295.
29. A.O.N.S.W. 3/5714.
30. *A.M.S.* 17/2/1894.
31. *H.G.* 23/12/1899.
32. *H.G.* 28/10/1899.
33. ibid.
34. Nairn 1981.
35. New South Wales Legislative Assembly 1892–93a; New South Wales Legislative Assembly 1892–93b.
36. Cotton et al. n.d.
37. *H.G.* 1/4/1900.
38. Carne 1912; Neale et al. 1981.
39. Mainwaring 1986b: 6.
40. ibid.
41. Coe n.d.

42. Gojak et al 1988.
43. A.O. Map 25228.
44. *H.G.* 28/10/1899.
45. *H.G.* 3/3/1900.
46. *H.G.* 28/10/1899.
47. *H.G.* 3/3/1900.
48. *H.G.* 28/10/1899, 3/3/1900.
49. ibid.
50. Threlfall 1895.
51. New South Wales Legislative Assembly 1892–93b.
52. Carne 1912.
53. *H.G.* 28/10/1899.
54. Thompson 1983.
55. Australia ICOMOS 1987.
56. For criticisms of the methodologies employed by industrial archaeologists, see Murray 1983 and Clark 1987.

BIBLIOGRAPHY

Published sources

AUSTRALIA ICOMOS 1987. *Charter for the conservation of places of cultural significance (The Burra Charter). Guidelines to the Burra Charter: cultural significance*, Australia ICOMOS (Inc.).

BAKER, C.A.W. 1971. The history of mining in New England, *Armidale and District Historical Society, Journal and Proceedings* 14: 64–75.

CARNE, J.E. 1912. *The antimony mining industry and the distribution of antimony ores in New South Wales,* Department of Mines, Mineral Resources No. 16.

CLARK, C.M. 1987. Trouble at t'mill: industrial archaeology in the 1980s, *Antiquity* 61: 169–79.

COE, T.B. (ed.) n.d. *The northern districts of New South Wales*, S.E. Lees, Sydney.

COTTON, F., McCREDIE, A.L. & DICKINSON, E.J. n.d. *Summary of the Colo River Electric Scheme,* privately published, Mitchell Library.

DALLAS, K.M. 1960. Water power in Tasmanian history, *Tasmanian Historical Research Association, Papers and Proceedings* 8(4): 85–93.

DAVISON, G., McCARTY, J.W. & McLEARY, A. (eds) 1987. *Australians 1988,* Fairfax, Syme and Weldon Associates, Sydney.

GREEN, F.C. 1959. Hydro-electric development in Tasmania, *Tasmanian Historical Research Association, Papers and Proceedings* 8(1): 3–11.

LEIGH, W.S. 1894. On the artificial method of lighting the Jenolan Caves, *Records of the Geological Survey of New South Wales* 4: 66–7.

MAINWARING, R. 1986a. *Tramways down the gorge: the story of Hillgrove 1887–1921*, Light Railway Research Society of Australia, Surrey Hills, No. 94.

MAINWARING, R. 1986b. *Tramways down the gorge: the story of Hillgrove 1937–1987*, Light Railway Research Society of Australia, Surrey Hills, No. 96.

MURRAY, T. 1983. Review of Birmingham, J.M., Jack, R.I. & Jeans, D.N. 1979. *Australian pioneer technology: sites and relics,* Heinemann, Richmond, Victoria, and Birmingham, J.M., Jack, R.I. & Jeans, D.N. 1983. *Industrial archaeology in Australia: rural industry*, Heinemann, Richmond, Victoria, *Australian Archaeology* 17: 129–33.

NAIRN, B. 1981. Francis Cotton (1857–1942), *in* Nairn, B. & Serle, G. (eds) *Australian dictionary of biography*, Melbourne University Press, Clayton, Vol. 8: 119–20.

NEALE, R.S., RAMSAY, G., FISHER, S. & HENNING, G.R. 1981. Life and death in Hillgrove 1870–1914, *Armidale and District Historical Society, Journal and Proceedings* 24: 31–57.

NEW SOUTH WALES LEGISLATIVE ASSEMBLY, 1892–93a. Select Committee on the Australasian Rights Purchase Bill, *New South Wales Legislative Assembly, Votes and Proceedings* 8: 307–30.

NEW SOUTH WALES LEGISLATIVE ASSEMBLY, 1892–93b. Select Committee on the Hillgrove and Armidale Water-Power Electrical Company, *New South Wales Legislative Assembly, Votes and Proceedings* 8: 337–55.

SCHOOLS COUNCIL, 1975. *Industrial archaeology of watermills and waterpower,* Heinemann Educational Books, London.

THOMPSON, P. 1983. *Power in Tasmania,* Australian Conservation Foundation, Hawthorn.

THORNTON, G.G. 1982. *New Zealand's industrial heritage,* Reed, Wellington.

THRELFALL, R. 1895. Anniversary address, *Proceedings of the Royal Society of New South Wales* 29: 1–30.

TRICKETT, O. 1922. *Guide to the Jenolan Caves, New South Wales,* Government Printer, Sydney.

TUCKER, D.G. 1977. Hydro-electricity for public supply in Britain, 1881–1894, *Industrial Archaeology Review* 1: 126–63.

UCHIDA, H. 1984. Survey of the industrial monuments of Japan, *in* Victor, S. & Wright, H.E., (eds) *Industrial Heritage '84: The Fifth International Conference on the Conservation of the Industrial Heritage,* Vol. 1, National Reports 1981–84, Society for Industrial Archaeology, Washington: 66–77.

Unpublished sources

A.O. Map 25228, Archives Office of New South Wales.

A.O.N.S.W. 3/5714. File 1275 Hillgrove and Armidale Water Power Electric Company Limited, company papers. Archives Office of New South Wales.

GOJAK, D., GIOPOULOS, G. & DUNNETT, G. 1988. Gara River hydro-electric scheme, Oxley Wild Rivers National Park, New South Wales, Conservation Plan. Unpublished report prepared for the National Parks and Wildlife Service of New South Wales.

KOZAKIEWICZ, M. 1982. Duck Reach and the electric light, Launceston. Research report prepared for Launceston College of Advanced Education.

THRELFALL, R. 1894–97. Letterbook. Sydney University Archives.

Newspapers

Australian Mining Standard (A.M.S.)

Hillgrove Guardian (H.G.)

Illustrated Sydney News (I.S.N.)

New South Wales Government Gazette (N.S.W.G.G.)