5. Vertical lift span bridges entries

5.1 BREWARRINA BRIDGE

(Brewarrina Type, built 1888)

5.1.1 Description of the Bridge

The Bridge over the Barwon River at Brewarrina consists of a wrought iron lifting span and timber beam approaches. The bridge has a single lane with a width of 4.5 m (15 ft.) between the kerbs and there are a total of four approach spans on each side of the bridge approximately 9 m (30 ft.) in length. The main lifting span is 16.8 m (55 ft.) in length thus combining to give a total bridge length of approximately 91 m (299 ft.). The upper framework of the lifting span consists of four wrought iron lattice towers with both transverse and longitudinal wrought iron lattice girders bracing the towers at the top. The supports of the lift span comprise of two piers made from pairs of tubes fabricated from curved and shaped wrought iron plates riveted together, and joined with cross ties forming elliptical holes for improved aesthetics. Finally the roadway itself is carried on wrought iron cross girders and stringers supporting timber decking. The separate components that make up the bridge are shown in Figure 5.1.

Figure 5.1 Oblique view of Brewarrina Bridge in 2008

Development of roads and transportation in the Brewarrina region

From 1830 settlers began taking up numerous portions of land along the river system and transportation of wool and other produce was initially conducted by teamsters, including horse and bullock teams. These teamsters had to pull wagons vast distances to reach their markets.

In 1859 Captain William Randell used the river boat named *Gemini* to make the journey up the Darling River to Brewarrina which opened the route for regular river boat traffic (Fraser, 1985). Brewarrina was transformed into a river port and local wool was disembarked from here to the downstream ports in Victoria and South Australia (The Barwon-Darling River: An Historic waterway). This loss of trade to rival colonies was of particular concern to the New South Wales Government of the time and capturing these commercial losses due to the river trade became the driving force behind the development of new railway networks in North Western NSW (Fraser, 1985).

A pontoon bridge was built at Brewarrina in 1870 (Figure 5.2). James Govan formed the company that built the pontoon and rented it to operators. The toll charges consisted of 1 shilling per bale of wool with other goods being charged 10 shillings per ton. Sheep charges were 30 shillings per thousand up to ten thousand, after which the rate was increased to £1 per thousand sheep. Following this a public punt was in operation from 1874 and served as the sole local crossing of the Barwon River until the completion of the existing bridge in 1888 (Thompson, 2003, p. 32).

Figure 5.2 Pontoon bridge at Brewarrina 1886 (Source: State Library of South Australia PRG 1258/2/2180)

Design and Construction

Finally, following a petition forwarded to the Minister for Public Works Mr. John Lackley, an extension of the railway network was constructed to Brewarrina. It was officially opened on the 2nd of September 1901 and the railway effectively replaced the river trade as the principle method of transportation for product. The Brewarrina Bridge consequently improved access to north western NSW as it allowed for product to easily cross the Barwon River to the new railhead for final transportation to Sydney, thereby achieving the goals of the NSW government and contributing significantly to the social and commercial development of the region (Fraser, 1985).

Balranald and North Bourke bridges came from essentially the same design by Public Works engineer J.H. Daniels. However, at Bourke the lift posts were not connected at their tops by longitudinal elements (parallel to the lift span) which allowed the post to deflect slightly inwards during the lifting operation which caused the lift span to jam between the post when nearing full lift.

Subsequently, in 1885 Percy Allan designed the lift bridge for Brewarrina and corrected the fault by having a fully braced upper framework to hold the tops of the posts in position in all directions (Allan 1924). The ironwork for the lift structure was supplied by Appleby Bros, London, who also supplied ironwork for some of the lattice rail and road bridges including the first Iron Cove Bridge at Drummoyne, Sydney and was opened on the 7th of December 1888. Compared to a similar bridge constructed at Bourke, the Brewarrina Bridge was a much cheaper structure, at £7700 compared to the £37900 for Bourke. The reduction was partly due to the use of cheaper timber approach spans, but more significantly, due to the lower transport costs. The railway to Bourke had been completed and the final road haul to Brewarrina was only 66 miles (100 km) (Fraser, 1985).

In 1896 E.M. De Burgh modified the lifting mechanism such that it could be worked by one man (Allan 1924).The other surviving pre-1915 lift bridges over the inland rivers are over the Darling River at Wilcannia (1896) which is out of service.

Operational History

Trade on the Darling River was a speculative affair as the height of the river depended on the unpredictable rainfall in Queensland. Consequently the Darling was either in flood or drought. When in drought, paddle steamers were left high and dry for as long as three years. The many bends in the river meant that barges were towed by a short line of only 50 feet long.

There are no accurate records available of the operational lifts made on the bridge, though test lifts were made intermittently. The arrival of the railway to Brewarrina resulted in the rapid demise of the river trade; paddle steamer (P.S.) *J.G. Arnold* was the last steamer into Bourke in 1932. It is considered likely that the lift span was locked in place soon after 1932.

Figure 5.3 **Darling River in flood in 1915 (Source: NLA)**

Maintenance History

The components of the lifting mechanism were originally the same as those designed by J. H Daniels and used in the two preceding vertical lift bridges at Balranald and North Bourke, with the only alteration being the introduction of a longitudinal shaft at the top of the winch side towers to ensure the sheaves rotated at the same speed so lifting at each end of the span was carried out in unison.

Despite all the above mentioned modifications, the design was still considered as unsatisfactory due to the two operator arrangement and in 1896 the bridges lifting gear, longitudinal girders and wind braces were upgraded by an E. M. De Burgh design. The longitudinal bracing girder was upgraded by adding in extra chords creating a lattice girder and the wind bracing was replaced with an alternate design with similar tie rod arrangement. Modifications applied to the longitudinal bracing girders also suggest that they may not have possessed sufficient stiffness to brace the towers and prevent encroaching on the movable span and resultant jamming. Further modifications to the lifting gear consisted of replacing the chains with wire ropes, the chain wheel with a rod spoke sheave and providing a lifting mechanism that could be operated by one man.

In 2000 overloading of the lift span resulted in severe damage to the trusses. The overloading caused critical buckling of the top chords (Figure 5.4) as well as collateral damage to other members. As a result of the damage to the lift span trusses large steel girders were installed adjacent to each lift span truss.

Figure 5.4 Steel girder supporting damaged movable span (Source: RMS)

5.1.2 Statement of Significance

Even though the damage to the lift span has caused some loss of heritage value the Bridge still satisfies the following heritage criteria:

- It has been and continues to be an important item of infrastructure in the history of NSW and is associated with the history of the river trade.
- It is strongly associated with famous Public Works engineers Percy Allan and E.M. De Burgh.
- It has strong aesthetic lines.
- It is highly valued by the local community.
- It is a technically sophisticated bridge structure for its time.
- It is a rare bridge because it, and the lift span at Bourke are the earliest surviving examples of vertical lift bridges in NSW.
- The Bridge is assessed as being of State heritage significance.

Source: RMS s170 Register

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Listed
OEH Heritage Division State Heritage Register	Not listed
Brewarrina Shire Council Local Environmental Plan, 2012	Listed
NSW National Trust Register	Listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications

In summary, the modifications to the designs used at Balranald and North Bourke Bridges consisted of the addition of bracing to the towers by way of longitudinal girders, wind bracing and the introduction of a longitudinal shaft across the top of the towers to ensure uniform lifting. Table 5-1 gives an overview of the modifications made to this bridge.

Table 5-1 Brewarrina Bridge Modifications

Preceding Designs	Issues with Design	Evolution at Brewarrina
No top restraint bracing of towers	Encroaching of towers causing pinching of lift span.	Top restraint of towers with longitudinal girders and wind sway bracing
Independent lifting of each end	Difficulty getting unison between two operators. Often caused jamming of span during lifts.	Lifting mechanism joined by longitudinal shaft

5.1.3 Description of lift span mechanism components

Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance.

The towers of the bridge consist of a wrought iron lattice structure with a curved top section and wrought iron plating at the base (Figure 5.5). The enclosed curved section appears to be designed to shelter the original chain wheel thus improving durability and aesthetics. This design was previously adopted for the vertical lift bridge erected at Balranald which has subsequently been demolished making this feature of design exceptionally rare.

The Brewarrina Bridge was the first lift span in NSW to adopt both longitudinal and transverse girder tower bracing. This marked a significant improvement over the previous designs which had continual issues with the towers impinging on each other and jamming the lift span as it was raised. The tower arrangement consists of longitudinal girders with transverse diagonal cross braced tie rods, thus providing top end restraints to the towers in all directions, eliminating excessive movement. This design improvement was carried throughout subsequent vertical lift bridges built in NSW.

The longitudinal girders are aligned with the towers giving an efficient load path for the bridge superstructure. The towers are restrained at their base by casting the bottom end into the unreinforced concrete fill of the wrought iron piers.

Figure 5.5 **Drawing and image of lattice towers and Warren type longitudinal bracing girders on Brewarrina Bridge (Source: RMS)**

Movable Span

The form and fabric of the lift span is of HIGH significance.

The movable span consists of a longitudinal wrought iron cross braced girder arrangement supporting wrought iron plate web cross girders (Figure 5.6). The stringers are also a wrought iron plate web girder construct that supports timber decking which has economic and weight advantages.

Brewarrina Bridge was the first vertical lift span bridge to utilise a timber deck rather than the previously used metal buckle plates.

The lift span was attached by a shackle to the chains in the original design. The lift span also has guides on each corner to prevent impaction on the towers during operation. After the 1896 modifications were made to the lifting arrangement, the wire ropes were connected to the lift span by way of ferrules and clamps around a pin supported in a suspension bracket at each corner.

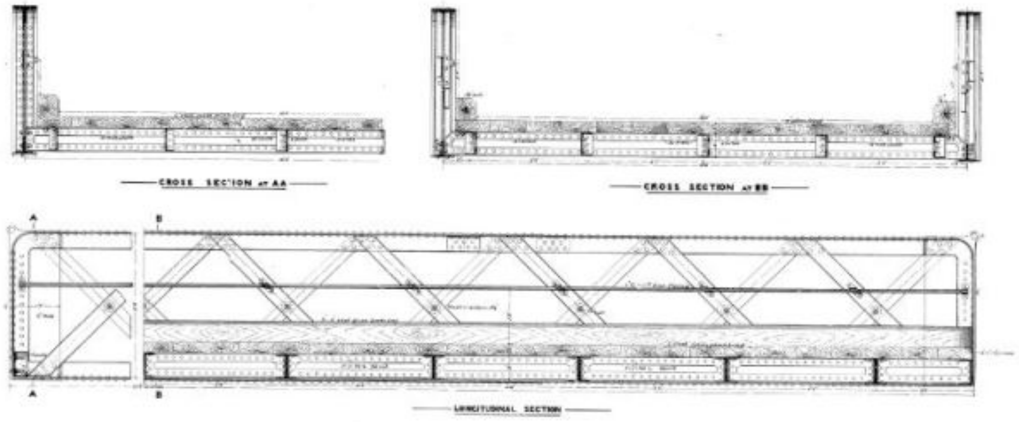


Figure 5.6 **Profiles of the movable span**

Following the closure of the bridge to lifting operations the timber decking has been extended across the joints. The current poor condition of the trusses and the presence of the large intrusive temporary support girders installed in 2000 have resulted in a reduction of the heritage value of this component.

Counterweights

The form and fabric of the counterweights is of HIGH significance.

The balance weights of the system were hung inside the lifting towers and were cast iron with adjustable lead ingot filling. This adjustment was to allow for any weight differences due to water saturating the timber deck or future modifications to the lift span. The transverse alignment of the top chain wheels and longitudinal girders was most likely to allow for this arrangement of balance weights. This arrangement also had the disadvantage of inducing an eccentricity into the lattice towers owing to the off-set of the sheaves by 12 in. to the centre line of the towers.

The counterweights are still in place attached to the cables. However, on closer inspection it would appear that the counter weights have been supported by angled sections as shown in Figure 5.7. This is believed to be a safety feature in case the cabling or attachments deteriorate and fail. However, it is only slightly obtrusive and does not take away from the impression that the lift system is operational.

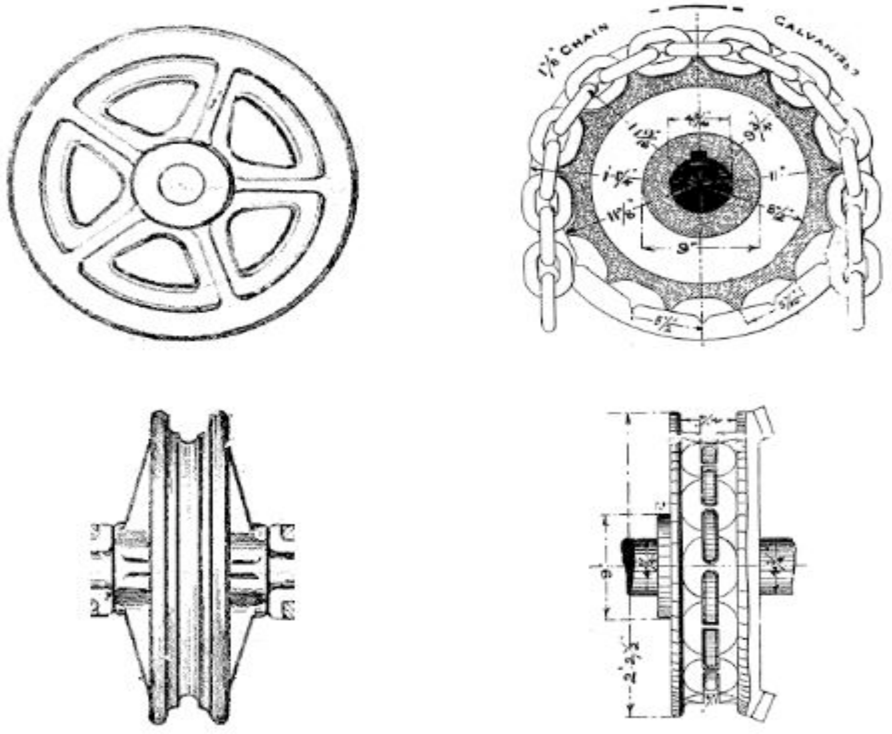
Figure 5.7 Propped counterweights and attached cables (Source: RMS)

Sheaves and winch drums

The form and fabric of the sheaves and winch is of EXCEPTIONAL significance.

Driving control of the lift span was originally achieved by way of chains as they are wound on winch drums located at the base of each tower. The winch drums on each pier were connected via a transverse shaft and are driven by a winch with a 16.5:1 mechanical advantage. Lifting chains were adopted in the design and consist of short link crane chains, this is also the last time they were implemented and from 1888 onwards cables made up of wires were used.

The chain wheels at the tops of the towers were orientated longitudinally and were most likely made of cast iron. The bevel chain wheel was driven as the chains passed over the wheel pulling the chain links against the purposely shaped chain link mouldings inside the wheel bevel thus lifting the span. As depicted in Figure 5.8, a comparison between the Balranald and Brewarrina chain wheels reveal the improved casting used which created teeth for greater traction of the chain in the wheel. It appears that the original chain wheels on the Bourke Bridge are a hybrid of the two chain wheel designs.



Balranald Chain Wheel **Brewarrina Chain Wheel**

Figure 5.8 Comparison of Balranald and Brewarrina chain wheels

The bridge was upgraded in 1896 which resulted in the chain wheels being replaced with new sheaves that supported wire ropes (Figure 5.9).

Figure 5.9 **Brewarrina Bridge sheaf and cable components (Source: RMS)**

Mechanical components

The form and fabric of the mechanical components is of HIGH significance.

The mechanical components generally consisted of a numbers of shafts and gears that were driven by a manually operated winch system (Figure 5.10).

One significant design adaptation made by Percy Allan was to connect the top bevel chain wheels on the winch side of the bridge by an overhead longitudinal shaft, which has subsequently been removed. This shaft was bevel geared into the chain wheels at each end and therefore ensured that the entire lift mechanism was connected resulting in a uniform span lift. The 1896 modifications replaced the chain and shaft mechanism with a wire rope arrangement with most of these components remaining today.

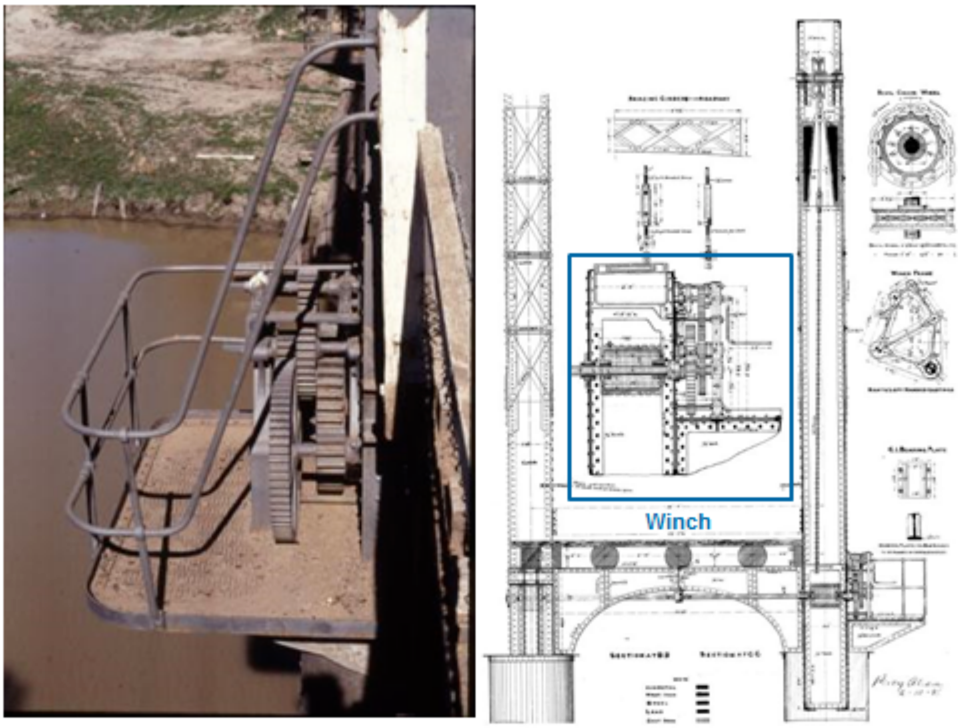


Figure 5.10 **Manually operated lifting winch mechanism (Source: RMS)**

Vehicle and pedestrian barriers

NO significance.

Vehicle and pedestrian barriers were never installed on Brewarrina Bridge.

Ropes

The form and fabric of the mechanical components is of LOW significance.

The ropes control the lift (Figure 5.11) however there is no available information on their construction. Due to the advanced age of the ropes these are now in very poor condition and well past their serviceable life.

Figure 5.11 Tower and rope connection to movable span (Source: RMS)

Motors and electrical

NO significance.

Motors and electrical components were never installed on Brewarrina Bridge. It remained manually operated throughout its serviceable life.

Actions required in order to restore the bridge to lifting operation

- Rehabilitate movable span trusses
- Re-deck movable span
- Reinstate wire ropes
- Overhaul mechanism

Summary of heritage assessments

The significance of each of the bridge components are summarised in the table below and presented visually in the Figure 5.12.

Table 5-2 Brewarrina Bridge - Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL
Movable Span	HIGH
Counterweights	HIGH
Sheaves and winch drums	EXCEPTIONAL
Mechanical components	HIGH
Vehicle and pedestrian barriers	NO
Ropes	LOW
Motors and electrical	NO

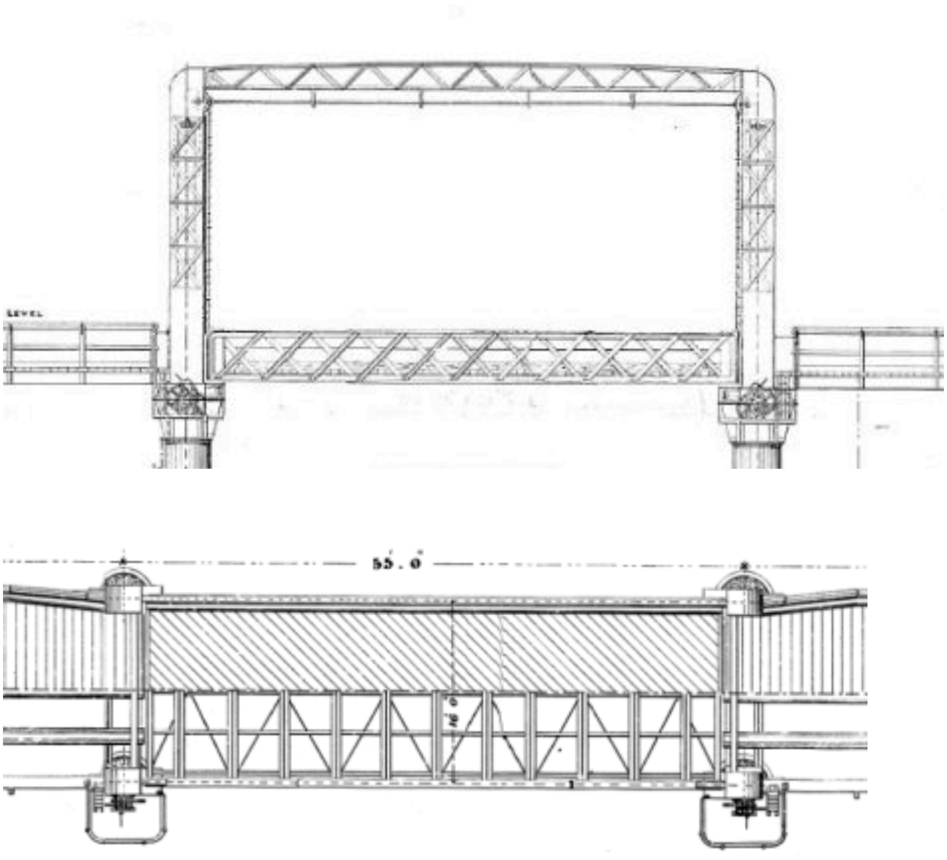


Figure 5.12 Brewarrina Bridge elevation and plan

5.2 SWAN HILL BRIDGE

(Swan Hill TYPE, built 1896)

5.2.1 Description of the Bridge

The Bridge over the Murray River at Swan Hill consists of two 27.9 m (91 ft.) timber Allan truss spans that flank a single 17.8 m (58 ft. 6 in) vertical lift span. There is a single timber beam approach span on the Victorian side of the Murray River and three timber beam approach spans on the New South Wales side. The bridge is 116 m (381 ft.) long and has a road width of 4.3 m (14 ft.) between kerbs on the movable span, 5.5 m (18 ft.) on the truss spans and 6.7 m (22 ft.) on the timber beam approach spans, accommodating a single lane of traffic. The separate components that make up the bridge are shown in the eastern elevation of Figure 5.13.

Figure 5.13 View of Bridge looking south

Development of roads and transportation in the Swan Hill region

Swan Hill had been an important crossing place for stock from its earliest periods of European settlement. In 1847 a punt was established and this was the only way of stock and goods crossing the Murray River for 160 km either side of Swan Hill as the nearest alternate crossings were at Echuca and Wentworth. Punt crossings were not always easy and the inconvenience of loading and unloading goods caused delays. Fees also had to be paid to use the ferry, levied on livestock and other produce, foot passengers, mail and horse-drawn vehicles.

The arrival of the paddle steamers *Lady Augusta* and *Mary Ann* in 1853 began a trade that by 1892 made Swan Hill Australia’s second largest inland port behind Echuca. Murray Downs Homestead was built at this time and had the largest river frontage on the NSW side, whilst the Beveridge brothers established Tyntynder on the Victorian side of the river.

The local support for a bridge was strong particularly after the arrival of the railway in 1889, and in 1890 prominent pastoralists were actively lobbying both the NSW and Victorian Governments. In January 1890 a public meeting took place at the Royal Hotel. The meeting was organized by the proprietor of Murray Downs Station, Mr. D. Johnson and Herman Moser, a prominent citizen and pastoralist in the area, who later brought out the Tyntynder property. Moser had been instrumental in the formation of the Stony Crossing Progress Association that sought to improve access between Swan Hill and NSW (Swan Hill Genealogical and Historical Society).

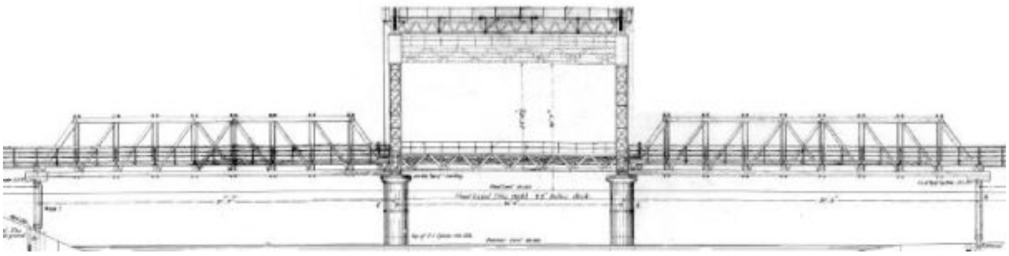
Design and construction

The two State Governments were presented with a petition and by 1894 plans were being drawn up for a bridge at Swan Hill and invitations to tender on the proposed bridge design were advertised in May of 1895. By June the contract was let to Messrs. J. B. and W. Farquharson of Melbourne, who in turn sub-contracted a Melbourne firm of Mephan, Ferguson & Co. for the metalwork (*TCJ* 1896). The timber used in the bridge came from the north coast of New South Wales and was sent by sea to Melbourne, then by rail to Swan Hill where the trusses were built in place. The *Swan Hill Guardian* questioned the wisdom of importing timbers over such a long distance insisting that local Victorian red gum was highly suitable for the job. Recent research and greater experience of timber bridge building in New South Wales had by this time recognised the superiority of tallow and iron bark for exposed areas, and innovative use of round timbers rather than square stringers, for example proved more structurally efficient (Nat. Trust, Vic).

Figure 5.14 Swan Hill Bridge under construction with lift tower in place (Source: Swan Hill Regional Library)

It is noteworthy that there are an alternate set of drawings for the bridge that have been signed by J. A. McDonald. The design drawings are almost identical to his designs for Tocumwal and Wilcannia. Figure 5.15 shows an elevation of both Swan Hill drawings, with the major difference being with the location of the winch mechanisms. It was built to the design by Percy Allan and also incorporates his timber truss spans which had only been developed two years earlier.

Percy Allan Swan Hill Design (Constructed) – Date on Drawings 1895



J. A. McDonald Swan Hill Design (Alternate) – Date on Drawings 1893

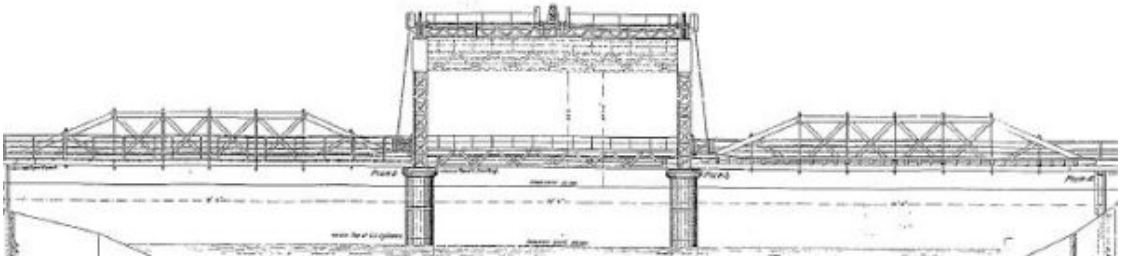


Figure 5.15 Allan and McDonald Design Drawings of Swan Hill

Construction of the Swan Hill Bridge started in 1895 and continued until 1896 at a total cost of £8900, whilst the punt was still operating upstream side of the bridge. On completion the bridge comprised one steel lift span supported on cast iron cylinders on bedrock, with concrete filled wrought iron cylinders above this

The approaches for the ferry on the New South Wales side were incorporated into the new bridge approaches (Nat Trust, Vic). The bridge was officially opened on 2nd December 1896 by the Victorian Minister for Works, Mr. J. W. Taverner and attended by a large crowd of people on both sides of the River. Most sources state that the honour of being the first to cross the bridge in a horse-drawn vehicle was given to Herman Moser (Gardner 1986: 30). Later that evening at a banquet to mark the occasion, Mr. Taverner responded to a toast made to Victoria, that he and the Victorian people were strong supporters of Federation (*TCJ*, 1896). The bridge was seen as tangible proof of what could be achieved by cooperation between the States.

On completion the bridge was compared to the recently built lift span bridge at Tocumwal, a shorter structure which had been considerably more expensive to build. The Swan Hill Bridge, built with timber where possible, had cost £8900 and that at Tocumwal, with iron side spans, had cost £19635. The saving in cost was attributed to the improved design of Mr. Percy Allan incorporating a more economical lift span, greater use of timber and the shallow depth of foundations required for the piers (*TCJ*, 1896).

The bridge at Swan Hill provided an important link between New South Wales and Victoria. Until the bridge at Barham was built 8 years later it was the only permanent crossing location in the area, particularly important in moving stock from New South Wales to the wharf at Swan Hill, where goods could then be freighted by rail, river or continue by road. Pastoralists from Barham and surrounds, found it preferable to bring their stock to Swan Hill rather than have them damaged in a punt crossing (McConnell et al 1994: 11). The span also allowed river trade to continue with minimal delays to both road and river traffic. Figure 5.16 shows a photograph taken soon after completion with the lift span raised for the passage of a steamer, whilst road traffic waits on the Bridge.

The bridge has been the focus of community celebrations during its 50th and centenary celebrations. A plaque was established on site for the latter in 1996. The Institution of Engineers, Australia also erected a Historic Engineering Marker plaque on the bridge in 2004.

Figure 5.16 View of the lift span in raised position with passing paddle steamer – c.1900 (Source: State Library of Victoria, image number: pi000942)

Operational history

The bridge caretaker responsible for operating the lift span and sweeping the deck lived in a small cottage on the NSW side of the river. Three long blasts of a riverboat whistle were used as a signal for the lift span to be raised.

Gradually the use of the lift span declined as riverboat trade and passenger services became less popular. At regular intervals the span was checked by the caretaker and any faults rectified.

In 1973 a request was put to raise the lift span for the passing of the steamer *Pevensey* in connection with the Port of Echuca Restoration project. By this stage the lift span was slow to operate. A water pipe connected to the Bridge in 1960 had to be disconnected first, and in some cases it was not possible to open the Bridge at all (RTA Bridge File 469.1339, Part 3). Test lifts were made on occasion since that time but accurate records of lifts have never been kept.

From the 1990s after more than ten years of drought and a low Murray River, maintenance efforts were directed away from the lift span of Swan Hill Bridge to higher priority projects. During this time river traffic was at a minimum and the high clearance under the bridge resulted in only 4 lift requests from river boats or paddle steamers in 2005. In 2007 during a planned operational lift it was found that the lift span was unable to be raised.

Repairs were subsequently scheduled and during these works, in early 2012, Roads and Maritime Services were advised that the “Paddle Steamer Melbourne Centenary River Festival” was being held on Sunday 9 September 2012 at Mildura, and several heritage paddle steamers and river boats were travelling downstream along the Murray River from Echuca to join the celebrations. This flotilla included the *PS Adelaide* which is the oldest surviving paddle steamer in Australia. Built in 1866 and operational along the Murray until the 1960s when it was placed in a park for around 20 years, it was fully restored and recommissioned in 1985, and it had been around 50 years since the *PS Adelaide* had been to Swan Hill.

PS Adelaide's voyage was heavily publicised through various media including farewell celebrations at the Port of Echuca when it set out on its journey. Repairs were completed in time for the festival and the lift span continues to be operated intermittently on request during prescribed times only without difficulty (Figure 5.17). In particular the paddle steamer *Pyap* built in 1896 operates regular day-trips from the Pioneer Settlement at Swan Hill, some of these necessitating the lift span to be raised.

Figure 5.17 Signboard detailing the off-peak traffic times when the lift span can be raised

Figure 5.18 Recent view of lift span raised for paddle steamer traffic

Maintenance history

The first maintenance records held by RMS for the Swan Hill Bridge began in 1925. A caretaker was appointed to the Bridge to operate the lift span and undertake general cleaning and maintenance of the Bridge. Maintenance at this early stage was carried out with assistance and input from the Victorian Department of Public Works (VDPW). In 1933 after approval for work was granted it was decided that half of the labour force was to come from Victoria, to be selected from a Government register for the unemployed (RTA

469.1339, Part 1). In 1936 the Department of Main Roads, NSW took over responsibility for maintenance.

Early in the Bridge's history an incident took place leading to the official prohibition of unauthorised persons from climbing onto any bridges in New South Wales. It was already common practice to display notices banning such activities but they had not carried any legal weight. In January 1925 a youth aged 16 who had been swimming in the nearby baths climbed onto the lift span and caught hold of a live electrical cable, resulting in his electrocution. The death was later judged to have been due to misadventure and served to highlight the dangers posed by bridges. Many bridges carried additional services (either pipes or cables) and this had been agreed upon by the Local Shire and the VDPW as long as it did not affect the working of the lift span. The electrical cables had been installed in 1912 to supply electricity to the caretaker's house and the Federal Hotel.

A proclamation was carried on the *Government Gazette* in August 1925 stating that:

"A person shall not climb upon any pier, tower or other portion of a bridge."

Another danger was identified in 1933 soon after the laying of two tracks running strips along the deck. The running strips were raised above the level of the deck and proved dangerous for horses especially when wet. They also limited the trafficable width of the bridge to single lane traffic and were removed.

The Bridge was also a focal point of community pride and celebrations. During festivities for Centenary Week in June 1936 the Bridge was "festooned' with electric lights and decorations. The local council however had not sought formal permission from the VDPW to do so and the decorations were removed soon after.

Quite often materials required for repairs were difficult to obtain and flooding would hamper the progress of work. The *Swan Hill Guardian* described the Bridge as being in a "shocking state of disrepair" due to the poor condition of the "rickety decking" which residents could hear up to half a mile away when vehicles were crossing (SHG 20/5/38). An internal memo noted that the Bridge was not nearly in as bad a condition as suggested by the paper, with the problem caused by the poor quality Murray Red Gum used for decking. This timber was prone to brittleness but was approved for use where it was difficult to obtain more suitable materials. The heavy flooding that occurred in 1939 then made it difficult for new supplies to get through and work could not be carried out until 1940. A visiting saw miller and road contractor to Swan Hill in 1940 described the Bridge as "rotten" and that blue gum should have been used. He further went on to say that the decking timber was laid in the wrong way (across the Bridge) and:

"Evidently New South Wales is a long way behind the times and far behind Victoria, in the art of timber bridge construction." (SHG, 26/4/1940)

When tenders were called in 1942 for supply of repair timbers none were received. The tender was then modified so that timbers other than ironbark would be accepted. The material was eventually obtained through the Timber Controller as this was:

"A main interstate bridge carrying a considerable amount of traffic and will possibly be used for military purposes." (RTA 469. 1339, Part 2).

Following a failed attempt to raise the lift span in 2007 (see above) an extensive repair and replacement program was commenced in August 2008. To counter the onset of rust a re-painting project was undertaken when the hazardous red lead paint coating was removed from the lift span towers within a plastic containment, and a new modern paint system applied. Extensive planning for mechanical repairs commenced at this time, and involved redesign, and complex fabrication processes to ensure components and systems met heritage requirements and current mechanical standards.

Figure 5.19 View of the scaffolding in place on the bridge between 2009 and 2012 to facilitate repainting of lift tower and replacement of mechanical components

Fabrication of selected new mechanical components commenced July 2011, involving a combination of historic and modern methods including forging, machining, casting and lead smelting for filling of the counterweights. During fabrication, material deficiencies in original cast metal components were identified, with some assessed as having the equivalent strength to red gum timber, which is unsuitable for current mechanical components.

The repair works involved multiple bridge closures to road traffic on weekends and week days. All of the new components arrived on site by August 2012, with the four large cast gear wheels arriving last. Large components requiring crane lifts were installed during several day and night closures as this had the least impact on the community.

A summary of the maintenance and repairs carried out on Swan Bridge is given in the table below.

Table 5-3 Maintenance on Swan Hill Bridge

Date	Description
1933-35	Clean and overhaul lift span machinery
1939-40	Lift span re-decked.
1949	Trial lift carried out; re-balancing required.

Date	Description
1965	New gears on lift span to replace those collapsed during lifting for passenger steamer.
1973-74	Repairs to bottom chords of lift span with new steelwork.
1999	Top and bottom chords of lift span were strengthened by the addition of welded steel channels and stiffener plates. Replacement of timber stringers supporting lift span deck with steel I-girders of same size.
2011	Lift span tower repainted. Additional counter weights added - 750 kg per corner. Hardwood and steel plate additions on the top of original counterweights were replaced with new steel counterweights.
2012	All sheaves and ropes were replaced like-for-like

5.2.2 Statement of significance

The Swan Hill Bridge is of historical and technical (scientific) significance to the State of Victoria for the innovations used in its design and construction. At the time of construction, the Swan Hill Bridge represented some of the most sophisticated methods in Australian bridge construction.

The Swan Hill Bridge is of historical significance for its associations with engineer Percy Allan who influenced bridge design throughout Australia and for its role in facilitating inter-colonial trade between New South Wales and Victoria.

Source: Victorian Heritage Database

Swan Hill Bridge, completed in 1896, is of State significance. The form and setting have high aesthetic and social significance. The superstructure construction - Allan timber Trusses and Allan Lift Span have very high significance in the detail and materials. The presence of the lift span is important. The bridge is the original of its type, and extremely rare. There is one other example at Tooleybuc.

Source: NSW State Heritage Register

Completed in 1896, the Swan Hill Bridge is an Allan type timber truss road bridge, and has a Warren type wrought iron vertical lift span to allow river craft to pass underneath. As a timber truss road bridge, it has many associational links with important historical events, trends and people, including the expansion of the road network and economic activity throughout NSW, and Percy Allan, the designer of this type of truss.

Allan trusses were third in the five-stage design evolution of NSW timber truss bridges and were a major improvement over the McDonald truss which preceded them. Allan trusses were 20% cheaper to build than McDonald trusses, could carry 50% more load, and were easier to maintain.

The vertical lift span is a rare feature, and has associated links with the historic river trade, and has much to reveal about late 19th century civil engineering and manufacturing technology. The bridge also includes Allan's improved one man operated lifting mechanism for the lift-span. This was the first bridge to use the mechanism, which was used on virtually all subsequent lift-spans in Australia. Swan Hill Bridge is assessed as being of state significance, primarily on the basis of its technical and historical significance.

Source: RMS s170 Register

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Listed
OEH Heritage Division State Heritage Register	Listed
Victorian Heritage Register (H0794)	Listed
Wakool Shire Council Local Environmental Plan, 2013	Listed
NSW National Trust Register	Listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications

In summary, the modifications to the previous designs consisted of the repositioning the winch mechanism back to the base of the tower and joining the sheaves to the winch by a particular configuration of vertical, longitudinal and transverse shafts. The gearing arrangement and use of a pinion to internal sheave teeth was new to this design. These modifications made the bridge cheaper, more reliable and easier to operate than the previous lift bridges built.

Table 5-4 Swan Hill Bridge modifications

Preceding Designs	Issues with Design	Evolution at Swan Hill
Winch mounted at centre of top longitudinal girders	Pinching of longitudinal shafts due to location of winch	Winch repositioned to base of tower.
Shafts directly rotate sheaves	-	Sheaves rotated by a pinion to internal sheave teeth.

5.2.3 Description of lift span mechanism components

Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance.

The towers of the bridge consist of a wrought iron lattice type structure with a square top section with wrought iron plating. Following on from preceding designs, the tops of the towers are restrained by longitudinal and transverse lattice girders and wind bracing (Figure 5.20 and Figure 5.21).

The overall geometry of the lift span is similar to the J. A. McDonald designs for Tocumwal and Wilcannia as evident by Figure 5.15, thus suggesting that the design is informed by the earlier work of J. A. McDonald. This is also confirmed by statements by H. Harvey Dare in 1896 that some difficulty was experienced with both the Wilcannia and Tocumwal designs due to deflections of the longitudinal girders giving rise to increased torsion in the longitudinal shafts. Hence a different system was adopted for the Swan Hill design which lowered the overhead platform back to deck level (Dare, 1896).

The alignment of the longitudinal lattice girders has been offset from the towers by approximately 4 ft. to facilitate the supporting arrangement of the transverse sheaves. It also provides support and access for the longitudinal shaft connecting the sheaves at the top of each tower. The base connection of the towers consists of setting the bottom section 6 ft. into the concrete infill of the wrought iron piers.

Figure 5.20 Lift span raised in 2013 during mechanical testing (Source: RMS)

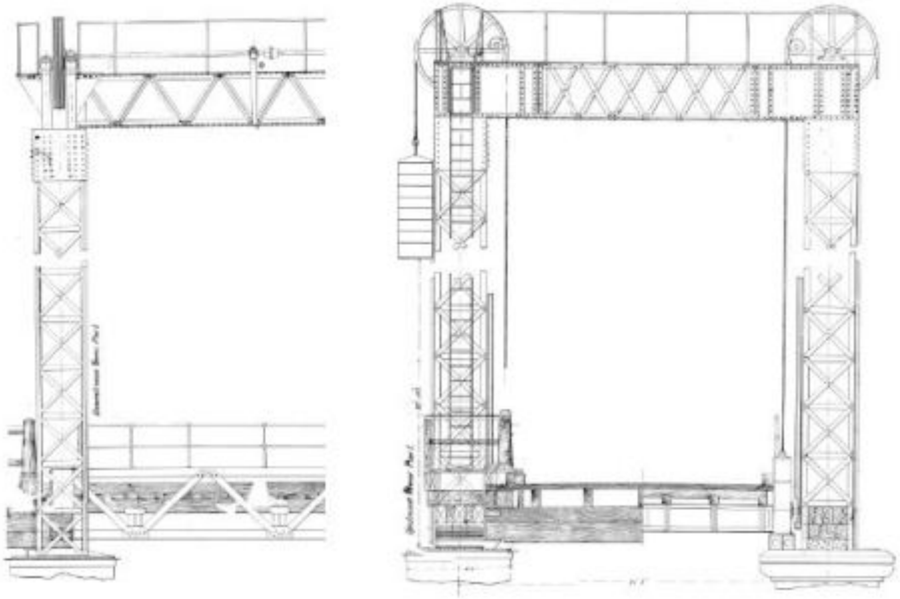


Figure 5.21 Drawing of lattice towers, transverse and longitudinal girders on Swan Hill Bridge

Movable span

The form and fabric of the movable span is of MODERATE significance.

The movable span consists of two main longitudinal steel Warren type girders supporting steel plate web cross girders (Figure 5.22). The cross girders vary between being straight at the terminal ends to support the headstock, and “fish bellied” for the intermediate girders. The stringers are of sawn timber that supports the timber decking. Connection between the lift span and the wire ropes is achieved by way of ferrules and clamps around a pin supported in a suspension bracket at each corner. The lift span also has inner guide wheels with an allowance for bearing on a bull-headed rail bolted down the side of the tower.

The bottom chords of the lift span trusses were strengthened in 1973-74. This work involved the welding of additional steel plates to the outside faces of the bottom chords. In addition, the top chords of the lift span trusses were strengthened in 1999 through the welding of a steel channel (toes down) to the top chords. This work was undertaken with the intent of limiting horizontal movement in the truss at deck level rather than increasing the structure’s load carrying capacity.

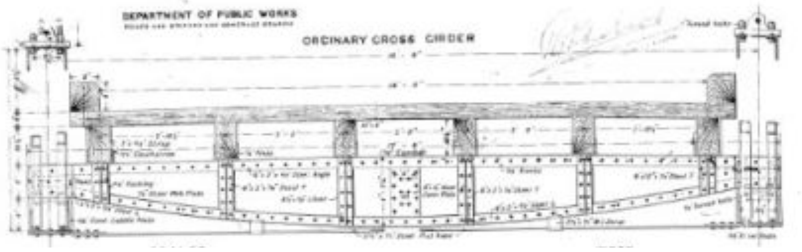


Figure 5.22 Swan Hill Bridge lift span ‘fish bellied’ member cross sections

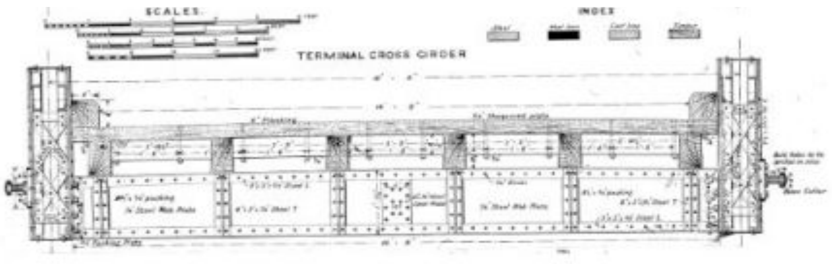


Figure 5.23 Swan Hill Bridge lift span terminal member cross sections

Counterweight

The form and fabric of the counterweight is of MODERATE significance.

The counter weights of the system were made of cast iron with adjustable lead ingot filling, they hung on the sides of the lifting towers. The balance typically weighed 34¼ tons though the lead ingot fillings allowed for adjustments in case of any weight fluctuations due to water saturation of the timber deck or future modifications to the lift span. The balance weights worked on steel solid core v section’s that were bolted to the two edges of the lattice tower facing the counter weights (Allan, 1924).

The arrangement of having the balance weights on the outside of the tower had two advantages. The first was a reduction in friction compared to positioning the weights inside the tower. The second advantage was that this arrangement allowed for the sheaves to be mounted on the centre line of the towers thus eliminating eccentricities that were present in previous designs. Swan Hill was the second design incorporating this improvement which was first implemented in the design of both the Tocumwal and Wilcannia Bridges.

The counterweights have been substantially modified from their original form and are currently under evaluation having been removed from the bridge (Figure 5.25).

Figure 5.24 Bridge shown soon after completion with lift span at maximum opening height and counterweights at deck level (Source: Annual Report Department of Public Works, 1895)

Figure 5.25 Counterweights under evaluation, removed from bridge (Source: RMS)

Sheaves and winch mechanism

The form and fabric of the sheaves and winch is of MODERATE significance.

All sheaves were replaced like for like in 2012.

Mechanical components

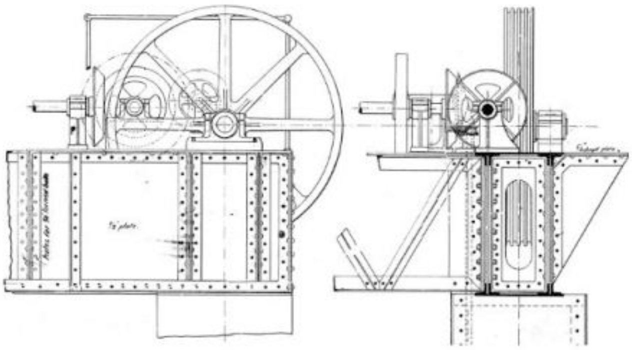
The form and fabric of the mechanical components is of MODERATE significance.

The lifting mechanism of Swan Hill Bridge is a further evolution on preceding designs. However the transverse orientation of the sheaves and heavy usage of shafts was previously adopted by J. A. McDonald in the design of both the Tocumwal and Wilcannia Bridges. Despite the arrangement of Tocumwal being a vast improvement on lifting mechanisms adopted in the past, there were still issues arising from the location of the winch. The designs of J. A. McDonald placed the winch mechanism on an overhead platform in the centre of the longitudinal lattice girders. The added weight of these winches and gearing caused excessive deflections of the lattice girder thus pinching the longitudinal shafts and inducing torsion in the system. The secondary disadvantage of time lost when scaling the towers to operate the systems was also a consideration for designers. In order to overcome the shafts pinching Percy Allan redesigned the lifting arrangement, bringing the winch mechanism back to deck level. This also offered a second advantage of the time saved since the operator no longer needed to scale the towers in order to commence a lift.

The driving control of the Swan Hill Bridge is provided by a combination of shafts and wire ropes (Figure 5.26 to Figure 5.28). The winch at deck level turns bevelled gears to a vertical shaft reaching up to the top of the tower. The direction of rotation is then transferred by a pinion and gear into the first longitudinal shaft that protrudes onto the mitred rim of the sheave causing rotation, thus lowering the balance weight and lifting the span that is joined to the wire ropes. The uniform transfer of driving force to all sheaves is provided by the linking of two longitudinal shafts by a transverse shaft. This arrangement also allows for the single person operation of the lifting bridge. All mechanical components were refurbished or replaced like for like in 2012.

Figure 5.26 2nd motion shaft and sheaves on VIC side down stream (Source: RMS)

Figure 5.27 Lifting gears and winding platform on Swan Hill Bridge (Source: RMS)



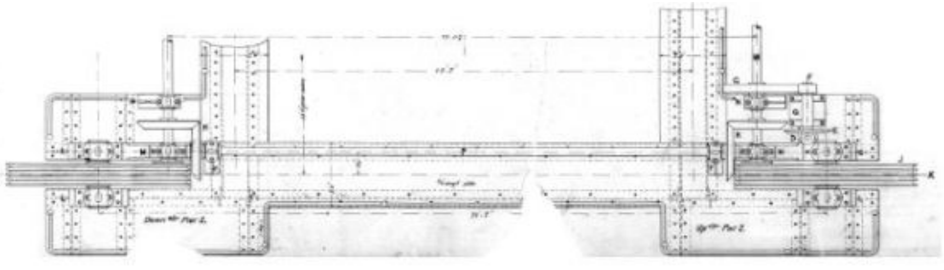


Figure 5.28 Plans of Swan Hill Bridge top sheaves, pinions and shafts

Vehicle and pedestrian barrier

The form and fabric of the vehicle and pedestrian barriers is of LOW significance.

Ropes

The form and fabric of the ropes is of LOW significance.

The use of wire ropes for a vertical lift mechanism was adopted in four preceding designs by J. A. McDonald. The first generation of wire rope lifting spans was in Mulwala and Wentworth Bridges. Issues with their use arose due to the unwinding of cables, the reason of which is unknown, though this same issue did not arise in the second generation of wire rope bridges of Tocumwal and Wilcannia. This suggests that it may have been the incorrect rope lay onto the winches, poor sheave arrangement or experimental sheave castings causing wear. The wire ropes that were installed at Swan Hill were 20.2 mm in diameter and composed of six strands around a core of hemp. Each strand contained seven mild crucible steel wires with the final design having a factor of safety of approximately 7.75 during the lift.

The designer, Percy Allan, deduced that the force required to lift the span was a combination of the wire rope self-weight, resistance due to bending over the sheaves and the overall friction in the system. The rope self-weight was taken as 430 lb and the combined bending resistance and friction as 1370 lb. Hence the required load to overcome was 1800 lb. This was met by allowing for an effective power of one man to be 18 lb and a gearing ratio of 34:1. The total time taken for one operator to lift the span was approximately 10 ¼ minutes.

The wire ropes were replaced in 2012.

Motors and electrical

NO significance.

Motors and electrical components were never installed on Swan Hill Bridge. It remained manually operated throughout the initial period of its operation. Since 1997 a hydraulic motor has been used to drive the opening mechanism of the bridge. Council officers bring the portable device to site in order to raise the bridge.

Summary of heritage assessments

The significances of each bridge component are summarised in the table below.

Table 5-5 Swan Hill Bridge - Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL

Bridge Component	Significance Grading
Movable Span	MODERATE
Counterweights	MODERATE
Sheaves and winch drums	MODERATE
Mechanical components	MODERATE
Vehicle and pedestrian barriers	LOW
Ropes	LOW
Motors and electrical	NO

5.3 DUNMORE BRIDGE

(Swan Hill Type, built 1899)

5.3.1 Description of the Bridge

Dunmore Bridge is an overhead braced Allan type timber truss road bridge. It has three timber truss spans, each of 34.2 m (113 ft.), 34.4 m (113 ft.), and 33.8 m (111 ft.). It has an internal steel truss lift span of 17.8 m (58 ft.). There is a single approach span at each end giving the bridge an overall length of 130.5 m (428 ft.). The bridge has a height restriction of 4.6 m because of the overhead bracing between the tops of the trusses. The separate components that make up the Bridge are shown in Figure 5.29.

Figure 5.29 General view of Bridge following truss replacement in 2012

History of transport on the Paterson River

The Woodville area was originally explored in June 1801 by Lieutenant Colonel William Paterson. The expedition noted the extensive cedar forests up from Newcastle and fifteen years later development of the region finally commenced when Captain Wallace was appointed as Commandant at Newcastle. He began sending cedar cuttings parties up the Hunter River, though generally settlement of the area was limited due to fears of the proximity to Newcastle penal settlement. The earliest known settler along the Paterson River was Captain William Dun after he received a grant in 1821 of 1,300 acres on the side of the Paterson River approximately 7 km north of Woodville. The occupancy of the area finally took off in 1823 when the penal colony was moved to Port Macquarie and numerous land grants were given by the Governor Sir Thomas Brisbane (Hunter, 1997: 1-3).

Prior to any bridges being constructed, the Paterson River was crossed by a punt situated approximately 100 m upstream of the current bridge location. This was replaced by an earlier Dunmore Bridge across the Paterson River (Figure 5.30). This bridge was a timber beam bridge with a sliding or traversing span that opened allowing for the passage of paddle steamers and large boats. This was one of the first of its type in NSW (Berger, 2012).

Only three bridges of this type were built in NSW and as none of these now remain they make for an interesting case study. These bridges have part of their structure built on top of one of the approaches with a shorter extension over the passageway so as to be in balance. The section on the approach rests on a roller on a track. The whole unit is drawn horizontally backwards on the approach so that the extension clears the passageway. Similar to a bascule they provide unlimited headroom but this type of bridge was considered obsolete by 1900.

However this bridge needed to be demolished and replaced as it was deemed “unsafe” after floods in 1895 caused scouring of the river bed triggering the two piers to sink. There were also other concerns raised by white ant attacks on the structure (The Morpeth and East Maitland want 15/12/1899). Hence a new bridge was proposed and the previously replaced punt was reinstated as a temporary crossing until this replacement bridge could be constructed.

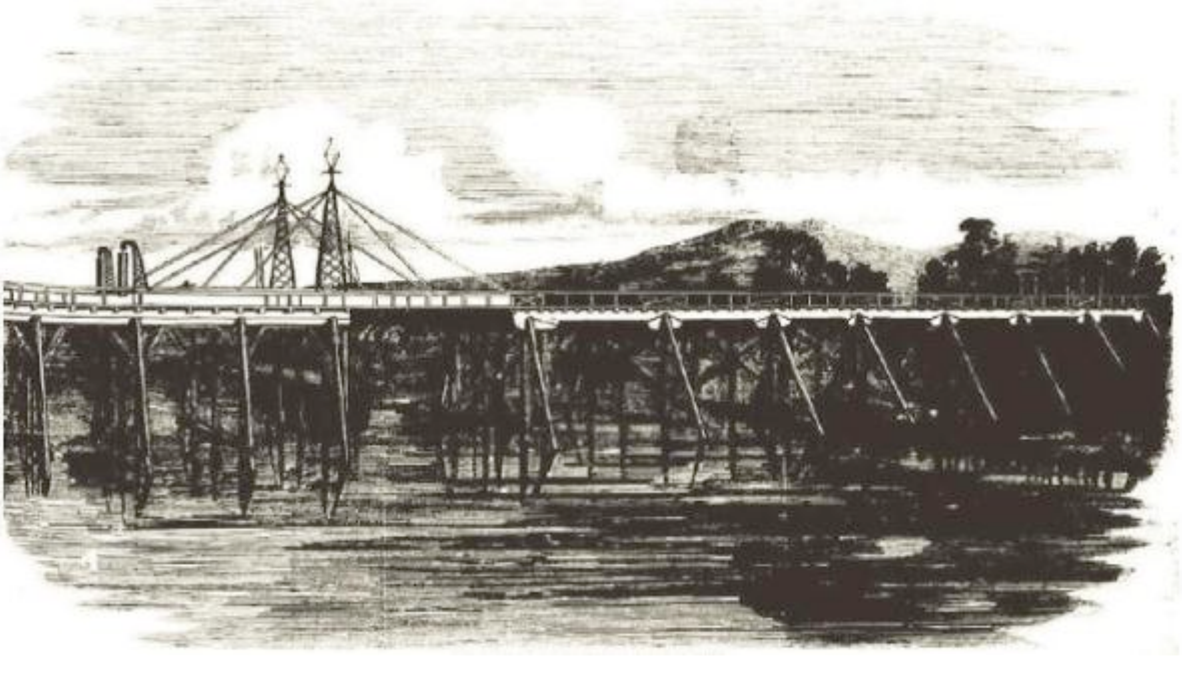


Figure 5.30 The first Dunmore Bridge (Source: Illustrated Sydney News, April 16, 1867)

Design and construction

The invitation to construct a new Dunmore Bridge was put out for tender in the *NSW Government Gazette* on 29th of June 1897 (#508: 4585). The requirement was for a "Lift Bridge over the Paterson River at Dunmore".

It is likely that the requirement for a lift bridge was to prevent restrictions to the navigation of the river. The region was a strong source of cedar, coal mining and producing salt and lime (Gorton 1982: 2). Hence retaining the river transport system was paramount to continual development of greater Newcastle.

In November of that same year S. McGill of Morpeth won the tender to build the bridge (GG #907: 8289). McGill was particularly well placed to take up the commission as he was in the process of completing the nearby Morpeth Bridge (1898) and later built Hinton Bridge (1901).

The existing Dunmore Bridge was built on the same alignment as the 1864 structure, which meant that during the 18 months taken to demolish the earlier bridge and build the new one, a punt was again required to transport people and vehicles across the River. Despite delays caused by flooding during August 1899 the bridge was completed and officially opened on the 14th of December 1899 with Mr Walter Bennet, MP praising "the people of Woodville upon having secured such a nice structure" (TMAEMW 15/12/1899). Figure 5.31 shows the bridge approximately 9 years after completion.

Figure 5.31 Dunmore Bridge in 1908 (Source: Digital Hunter, Newcastle Library)

The delays caused minimal grievance to residents as mention in the local paper during September 1899 that "The flood has somewhat interfered with the progress of our bridge, as some of the timber was washed away. This is a pity, not only for Mr McGill, but also for all the travelling public, who are anxiously waiting the completion of the bridge, having no relish for the punt" (TMAEW 1/9/1899).

As a further testament to the enthusiasm of the local residents is was estimated that five to six hundred people turned up to the opening ceremony on 14 December 1899 and marched across the bridge. The ribbon was cut by

Mrs Henry Croaker who was the wife of the Woodville Progress Committee president and a number of sporting activities were competed in during the day (TMAEMW 15/12/1899). The total cost of construction of the Bridge was £12,546 9s 11d.

Operational History

Morpeth was the major Hunter port on the river system. Ocean going vessels would proceed to Morpeth and smaller craft would continue to Maitland and Paterson. Most of the Paterson River traffic was smaller boats and shallow-draught droghers that sometimes stopped at individual farms to pick up and unload. However, the principal wharf of the area was Paterson. It was well equipped and busy but as the river silted up, caused partially by the turbulence from the river boats, the vessels became smaller, and eventually it was only the 'cream' boats that plied the river.

A cottage on the Dunmore side was provided for the bridge caretaker, the last of whom was Mr Franklin. When the bridge was first built the caretaker was required to maintain the road half a mile each side of the bridge, but as this meant delays to steam-boats when he was absent on road-work, the latter task was eliminated and the only extra duty was sweeping the bridge as horse drawn vehicles were the chief transports on our roads (Hunter, 1997: 11). From the plans of the present bridge it appears that the operator's cottage was built for the operator of the sliding section of the first Dunmore Bridge, and was retained for that purpose when the second bridge was built.

There are no accurate records available of the operational lifts made on the bridge, though test lifts were made intermittently. When the lifting span was fixed in position in 1940 the caretaker's role ceased though the cottage is still standing and has remained in private ownership.

Figure 5.32 **View of Dunmore Bridge in 2008 with former caretaker's cottage in foreground**

Maintenance History

The lifting span on Dunmore Bridge was fixed in position in 1940 as the need for it to be raised to allow the passage of river traffic ceased. The bearing ropes and counterweights were removed in 1949.. The deck and trusses of the lift span was replaced in 2003 as shown in Figure 5.35. The lift tower was painted in 2008 and the timber truss spans replaced in 2012.

5.3.2 Statement of significance

Completed in 1899, the Dunmore Bridge is a representative example of an Allan truss road bridge, and is one of three surviving overhead braced timber truss road bridges in NSW. The bridge also has a lift span to allow river traffic under it, which is a rare feature that also contains much technical significance and information about engineering technology of the late 19th century. Most of its engineering details are intact, and the bridge is in good condition.

As a timber truss road bridge, it has strong associations with the expansion of the road network and economic activity throughout NSW, and Percy Allan, the designer of this type of truss.

Allan trusses were third in the five-stage design evolution of NSW timber truss bridges, and were a major improvement over the McDonald trusses which preceded them. Allan trusses were 20% cheaper to build than Mc Donald trusses, could carry 50% more load, and were easier to maintain.

The people who live in the area around the bridge (Woodville and the Hunter region) value the bridge highly, and as such it has social significance.

Dunmore Bridge is located in the Hunter region, which has 15 historic bridges each constructed before 1905, and it gains heritage significance from its proximity to the high concentration of other historic bridges in the area.

In 1998 there were 38 surviving Allan trusses in NSW of the 105 built, and 82 timber truss road bridges survive from the over 400 built.

The Dunmore Bridge is rare and representative example of Allan timber truss road bridges, and is assessed as being nationally significant, primarily on the basis of its technical and historical significance.

Source: RMS s170 Register

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Listed
OEH Heritage Division State Heritage Register	Listed
Victorian Heritage Register (H0794)	Listed
Maitland City Council Local Environmental Plan, 2011	Listed
NSW National Trust Register	Listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications

In summary, the design was unchanged between Dunmore Bridge and its immediate predecessor Swan Hill Bridge due to its satisfactory performance.

5.3.3 Description of lift span mechanism components

Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance.

The design of Dunmore Bridge is identical to the one adopted for the Swan Hill Bridge. A direct comparison between both sets of drawings shows that essentially the name was the only item altered on the vertical lift span. It should be noted however, that differences between the two bridges exist with pier dimensions and the timber approach spans.

The towers of the bridge consist of a wrought iron lattice type structure with a square top section with wrought iron plating (Figure 5.33). Following on from preceding designs, the tops of the towers are restrained by longitudinal and transverse lattice girders and wind bracing.

The alignment of the longitudinal lattice girders has been offset from the towers by approximately 4 ft. to facilitate the supporting arrangement for the transverse sheaves. It also provides support and access for the longitudinal shafts connecting the sheaves at the top of each tower.

The base connection of the towers consists of setting the bottom section 6 ft. into the concrete centre of the wrought iron piers.

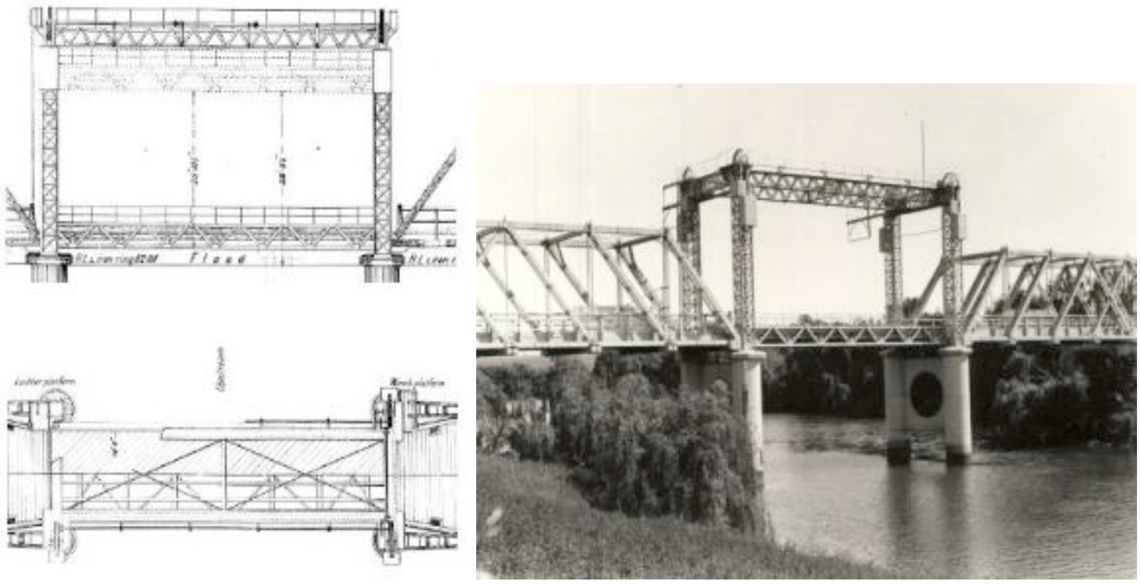


Figure 5.33 Plan, elevation and 1935 image of Dunmore Bridge (Source: RMS)

Movable Span

The form and fabric of the movable span is of LOW significance.

The movable span consists of two main longitudinal wrought iron Warren type trusses that support the steel plate web cross girders. The cross girders vary between being straight at the terminal end to support the headstock and “fish-bellied” for the intermediate cross girders (Figure 5.34). The stringers are of sawn timber construct that supports the timber decking. Connection between the lift span and the wire ropes is achieved by way of ferrules and clamps around a pin supported in a suspension bracket at each corner. The lift span also has inner guide wheels with an allowance for bearing on a bull-headed rail bolted down the side of the towers.

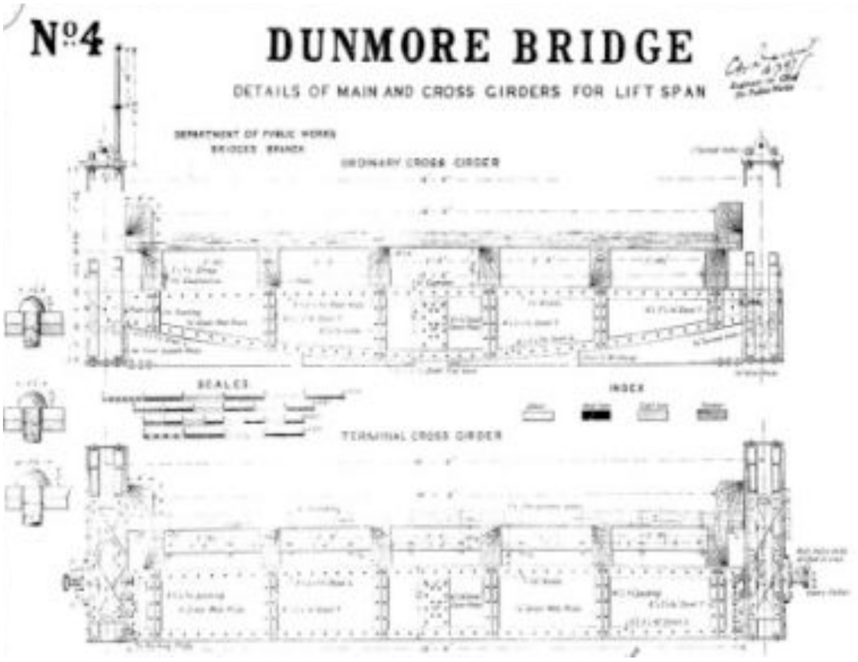


Figure 5.34 Cross sections of the Dunmore lift span

The movable span has since been replaced (Figure 5.35).

Figure 5.35 Replacement of Dunmore Bridge movable span (Source: RMS)

Counterweight

The form and fabric of the counterweight is of NO significance.

The counter weights of the system were hung on the sides of the lifting towers and were cast iron with adjustable lead ingot filling. The counter balance typically weighed 34¼ tons though there was an allowance for adjustments in case of any weight fluctuations due to water saturation of the timber deck or future modifications to the lift span. The balance weights worked on steel solid core v section's that were bolted to the two edges of the lattice tower facing the counter weights.

As with the Swan Hill design, the arrangement of having the balance weights on the outside of the tower had two advantages. The first was a reduction in friction compared to positioning the weights inside the tower. The second advantage was that this arrangement allowed for the sheaves to be mounted on the centre line of the towers thus eliminating eccentricities. However, these were removed in 1949.

Sheaves and winch mechanism

The form and fabric of the sheaves and winch is of MODERATE significance.

The sheaves consist of a cast iron wheel which is mounted at the top of each tower. They have four grooves set in to each that contain the wire ropes during operation. Driving power is provided to the system by a manually operated winch mounted at the base of one tower (Figure 5.36).

Figure 5.36 Top sheave & gearing and winch mechanism (Source: RMS)

The force required to lift the span was a combination of the wire rope self-weight, resistance due to bending over the sheaves and over all friction in the system. The rope self-weight was taken as 430 lb and the combined bending resistance and friction as 1370 lb. Hence the required load to overcome was 1800 lb. This was met by allowing for an effective power of one man to be 18 lb and a gearing ratio of 34:1. The total time taken for one operator to lift the span was approximately 10 ¼ minutes.

Mechanical components

The form and fabric of the mechanical components is of MODERATE significance.

The lifting mechanism of the Dunmore Bridge is also a direct replica of the Swan Hill Bridge design. The driving control is provided by a combination of shafts and wire ropes. The winch at deck level turns bevelled gears to a vertical shaft reaching up to the top of the tower. The direction of rotation is then transferred by a pinion and gear into the first longitudinal shaft that extends onto the mitred rim of the sheave causing rotation, thus lowering the counter weight and lifting the span that are joined by the wire ropes. The uniform transfer of driving force to all sheaves is provided by linking the two longitudinal shafts by a single transverse shaft. This arrangement also allows for the single person operation of the lifting bridge and eliminates the time lost in scaling the bridge to operate the winch.

Vehicle and pedestrian barrier

The form and fabric of the vehicle and pedestrian barriers are of LOW significance.

Ropes

The form and fabric of the ropes is of LOW significance.

The wire ropes that were installed at Dunmore were composed of six strands around a core of hemp. Each strand contained seven mild crucible steel wires.

However, these were removed in 1949.

Motors and electrical

NO significance.

Motors and electrical components were never installed on Dunmore Bridge. It remained manually operated throughout the initial period of its operation.

Summary of heritage assessments

The significances of each bridge component are summarised in the table below.

Table 5-6 Dunmore Bridge - Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL
Movable Span	LOW
Counterweights	MODERATE
Sheaves and winch drums	MODERATE
Mechanical components	MODERATE
Vehicle and pedestrian barriers	LOW
Ropes	LOW
Motors and electrical	NO

5.4 HINTON BRIDGE

(Hinton Type, built 1904)

5.4.1 Description of the Bridge

The Bridge over the Paterson River at Hinton consists of a wrought iron vertical lifting span with a length 58 ft. and two Allan type truss spans of length 92 ft. and seven timber approach spans combining to the give the bridge an overall length of 589 ft. The bridge has a clearance over high water line of 47 ft. when lifting span is closed and 73 ft. when the lifting span was opened.

The upper framework of the lifting span consists of four wrought iron lattice towers with both transverse and longitudinal wrought iron lattice girders connecting the towers at the top. The supports of the lift span comprise of two piers made from pairs of tubes fabricated from curved and shaped wrought iron plates riveted together, and joined with cross ties forming elliptical holes for improved aesthetics. The piers then continue as cast iron concrete filled tubes below the waterline.

Figure 5.37 View of Hinton Bridge with Bailey support structures on truss spans in 2004

Figure 5.38 View of lift span and timber truss spans from riverbank

History of transport on the Paterson River

The Hinton area has a similar history to the region surrounding Dunmore Bridge. The area was originally explored in June 1801 by Lieutenant Colonel William Paterson, on the ship the *Lady Nelson,* to assess the nature of the coal deposits (Palmer 1999: 3). The expedition noted the extensive cedar forests up from Newcastle and fifteen years later development of the region finally commenced when Captain Wallace was appointed as Commandant at Newcastle. He began sending cedar cutting parties up the Hunter River, though generally settlement of the area was limited due to fears of the proximity to the Newcastle penal settlement. The earliest known settler along the Paterson River was Captain William Dun after he received a grant in 1821 of 1,300 acres on the side of the Paterson River, approximately 2.5 km below Paterson. The occupancy of the area finally took off in 1823 when the penal colony was moved to Port Macquarie and numerous land grants were given by the Governor Sir Thomas Brisbane (Hunter, 1997: 1-3).

The primary role played by the major rivers in the lower Hunter region during the early 19th century was to provide transportation routes for the area. Shipping was an effective logistics tool and provided easy access to both Sydney and overseas markets. Hence following the cessation of the convict settlement, when the region became a hive of agricultural activity, ports such as Hinton and nearby Morpeth facilitated this need for the transportation of goods. The first passage over the Paterson River at Hinton was provided by a ferry which was in use by about 1848.

Design and construction

Hinton Bridge was designed by E. M. De Burgh as evident by his signature on the bridge plans. However, the implementation of the Allan type truss approach spans and the fact that this was one of the first vertical lift bridges designed by De Burgh, suggests that his design may have been completed under the direction of Percy Allan.

Figure 5.39 Side view of Hinton Bridge in 1901, note ferry at left (Source: Digital Hunter, Newcastle Library)

Tenders for the "erection of a lift bridge over the Paterson River at Hinton" were called for in the *NSW Government Gazette* (#676: 5933) in August of 1898. In December of that year it was announced that the tender of S. McGill of Woodville had been accepted (*GG* # 976: 9761).

Mc Gill at that time was at work in Woodville on the Dunmore Bridge, and many of the men who worked on that bridge were, upon its completion, transferred to Hinton (*The Morpeth and East Maitland Want* 10/11/1899). McGill had also constructed the Morpeth Bridge over the Hunter River (completed June 1898) which, along with the Hinton Bridge was to:

Admit the traffic from Morpeth proceeding to Hinton and thence northwards without having to use the Hinton Ferry as at present (*Report of the Department of Public Works* 1898: 13).

McGill commenced work at Hinton by early 1900. In September of 1900 meetings were held to discuss the opening of the Bridge and arrange a sports day in celebration. It was decided that a regatta would be most appropriate "as the River is a splendid one for this purpose" (*TMAEMW* 14/9/1900). There was some delay, however, in the completion of the Bridge, and meetings to discuss an opening ceremony were held again in January 1901. The first was poorly attended, but those who did attend were quite adamant that "it would be a disgrace to Hinton if there was no celebration after 30 years efforts to get the Bridge" (*TMAEMW* 18/1/1901).

Opening festivities were organised and they took place on the 13th of February 1901. Unfortunately the day turned out to be very hot "thereby considerably marring all pleasure". Despite the heat, some 1500 people were estimated to have been in attendance, including children from schools at Hinton, Morpeth, Wallalong, Largs, Woodville and Nelson's Plains. Amongst the notables in attendance were a number of Members of the Legislative Assembly and the Mayor of Hinton.

The Bridge was christened 'Hinton Bridge' with a bottle of champagne that had been kept 12 years for the purpose. The erection of the Hinton Bridge completed the line of communication between Morpeth, Hinton and northwards via Phoenix Park (PWD AR 1899).

The end cost of the Bridge was £10, 156. 4. 7 (*DPW* 1901: 9). It was noted by the Public Works Department in 1899 that the lifting span used on the Hinton Bridge was of a new design:

In connection with the Hinton and Murwillumbah Bridges, attention may be called to the improved machinery for raising the lifting span, by the adoption of a system of wire ropes in lieu of shafting overhead, a considerable saving in the cost of construction being effected thereby (DPW 1899: 11).

Operational history

Morpeth was the major Hunter port on the river system. Ocean going vessels would proceed to Morpeth and smaller craft would continue to Maitland and Paterson. Most of the Paterson River traffic was smaller boats and shallow-draught droghers that sometimes stopped at individual farms to pick up and unload. However, the principal wharf of the area was Paterson. It was well equipped and busy but as the river silted up, caused partially by the turbulence from the river boats, the vessels became smaller, and eventually it was only the 'cream' boats that plied the river.

The centenary celebration brochure for the bridge notes that several lifts took place in the year of its opening, 1901, to celebrate Federation. By the time the railway arrived in 1911, there was little river traffic. Plans of a two storey caretaker's cottage to be built beside the bridge in 1902 have been located, though this was never built. This suggests that lifts were infrequent though the number of annual lifts has not been recorded, nor the typical riverine traffic that would require the bridge to open.

Adjustments were necessary to the lift span in 1927, possibly as a result of jamming during opening or closing. One of the side trusses on the lift span was damaged by vehicular impact in 1947 and the lift span was locked in 1948.

Maintenance history

The responsibility for maintenance and repair of the Bridge was taken over by the Department of Main Roads from the Department of Public Works in July 1929.

Some of the more notable structural alterations known to have been made to the Hinton Bridge include the construction of two timber beam spans, on the eastern approach some time prior to 1927, the permanent fixture of the lift span in 1948 and the removal of the lift span counter weights (RTA file 307.142). An extensive capacity upgrade was undertaken of the lift span, trusses and approach spans between 2005 and 2007. The piers and lift span towers were re painted in 2009.

Maintenance and repairs recorded in the RTA (DMR) bridge files are summarised below.

Table 5-7 Hinton Bridge maintenance history

Date	Description	Cost
1927	Lift span re-adjusted.	
1928/29	Deck patched.	
1930	Some decking replaced, repairs to all spans (beam, truss and lift) including replacement of some stringers, beams, corbels and cross beams.	£720.
1931	Some decking damaged by overloaded trucks.	£220.
1939/40	Steelwork painted, also decking repairs.	£550.
1947	Car crashed into Hinton side of lift span, tearing off an iron support and splintering a post.	
1948	Lift span not seated properly. Approval received from Maritime to maintain it as a fixed span. Lead counterweights removed and stored.	
1956/59	Ironwork required chipping, cleaning and painting, ironwork.	Est. £5, 348.
1972	Postmaster General's Office requested permission to attach a cable to the Bridge.	
1973	Water pipe attached to bridge.	
1981/84	Lift span and fences repainted, parts of truss in span 10 replaced – Bailey truss required for repairs.	$10, 695. 39.
1984	Steel and timber required cleaning, treating and painting.	Est. $30, 000.
1985/87	Repainted, timber repairs (including complete re-sheeting of deck) and deck sealed.	$139, 571. 10.
2005-2007	New truss approach spans and lift span	$10 M.
2009	Re-paint lift span towers and piers	$0.5 M.

5.4.2 Statement of significance

Completed in 1901, Hinton Bridge is an Allan timber truss road bridge, and has a lift span which in the past accommodated river steamers that travelled the Hunter and Paterson River systems. Hinton is one of only three lift bridges in the Hunter region. Most of its engineering details are intact, and the bridge is in good condition. As a timber truss road bridge, it has many associational links with important historical events, trends, and people, including the expansion of the road network and economic activity throughout NSW, and Percy Allan, the designer of this type of truss. Allan trusses were third in the five-stage design evolution of NSW timber truss bridges, and were a major improvement over the McDonald trusses which preceded them. Allan trusses were 20% cheaper to build than Mc Donald trusses, could carry 50% more load, and were easier to maintain. The people who live in the area around the bridge value the bridge highly, and as such it has social significance. Hinton Bridge is in the Hunter Region, which has 15 historic road bridges each constructed before 1905. It gains heritage significance from its proximity to the high concentration of other historic bridges. In 1998 there were 38 surviving Allan trusses in NSW of the 105 built, and 82 timber truss road bridges survive from the over 400 built. Hinton Bridge is a representative example of Allan timber truss road bridges, and is assessed as being Nationally significant, primarily on the basis of its technical and historical significance.

Source: RMS Section 170 register

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Listed
OEH Heritage Division State Heritage Register	Listed
Victorian Heritage Register (H0794)	Listed
Maitland City Council Local Environmental Plan, 2011	Listed
NSW National Trust Register	Listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications

In summary, the modifications consisted of re-orientating the sheaves in the longitudinal direction and then connecting the opposite sheaves via wire ropes to ensure a uniform lifting operation. The use of a stretching screw for the rope to lift span attachment and the implementation of wire rope guides is one of the first examples in vertical lift bridge designs. Finally the adoption of large gusset plates at the top of the tower where both the transverse and longitudinal lattice girders are attached to the towers was a further improvement on previous designs.

Table 5-8 Hinton Bridge modifications

Preceding Designs	Issues with Design	Evolution at Hinton
Sheaves connected via longitudinal shafts.	Pinching of longitudinal shafts due to deflections	Wire ropes used to connect sheaves in longitudinal direction.
Suspension bracket and pin used to fix wire ropes to lift span.	No allowance for adjusting length of rope.	Stretching screw allows for adjustment of rope length.
No gussets adopted in any designs.	Either excessive deflections or oversized members adopted.	Large gussets used in both transverse and longitudinal directions.

5.4.3 Description of lift span mechanism components

Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance.

The Hinton Bridge is the product of the first attempt by E. M. De Burgh to design a vertical lift bridge. It must be noted that the descriptions adopted for Hinton Bridge are based on drawings for Murwillumbah Bridge completed in the same year. References to Hinton throughout these drawing allow for the fair assumption that the same design was adopted for both bridges.

The towers of the bridge consist of a wrought iron lattice type structure with a square top section with wrought iron plating. Following on from preceding designs, the tops of the towers are restrained longitudinal and transverse lattice girders and wind bracing (Figure 5.40).

The longitudinal lattice girders are aligned with the towers and unlike previous designs, they are not required to support longitudinal shafts as the lifting mechanism adopts ropes to control the lifting of the span. The implementation of gusset plates at the connection of both the transverse and longitudinal girders to the tower is one of the first times it has been seen in the evolution of the vertical lift bridge designs. These act to increase the overall stiffness of the superstructure and further minimise tower deflections.

The base connection of the towers is consistent with other designs and is achieved by setting the bottom section 6 ft. into the concrete centre of the wrought iron piers.

Lift span towers were completely repainted in 2009.

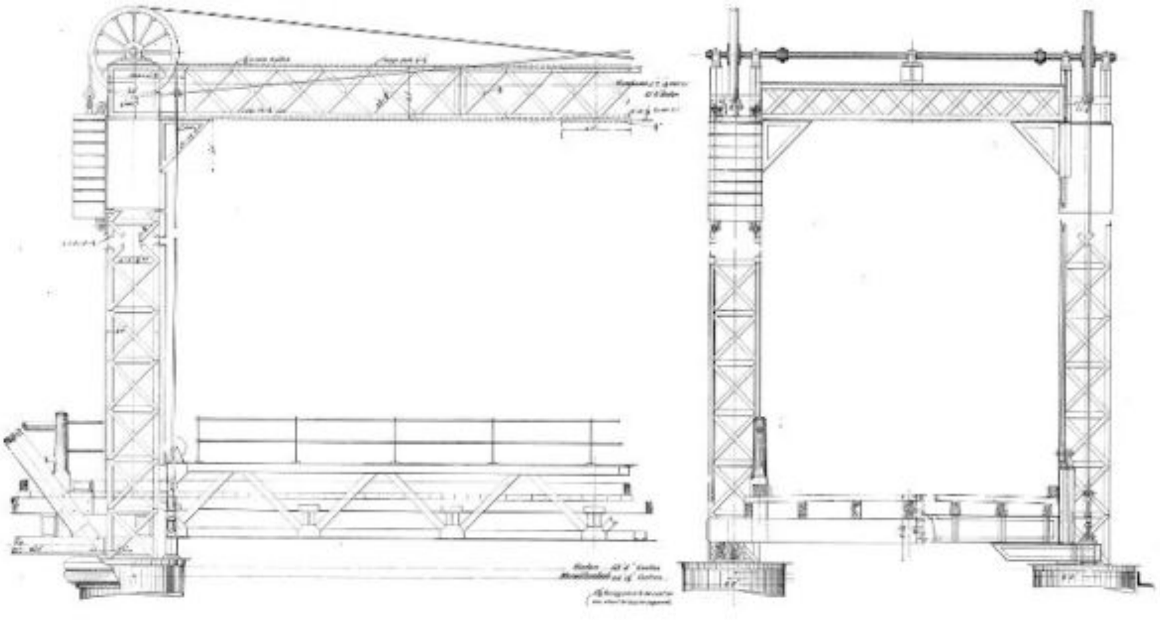


Figure 5.40 Drawing of lattice towers, transverse and longitudinal girders on Hinton Bridge

Movable span

The form and fabric of the movable span is of LOW significance.

As built originally the lift span consisted of two main longitudinal Warren type trusses supporting steel plate cross web girders. The stringers were of sawn timber construct that finally supported the timber decking (Figure 5.42).

The connection between the ropes and the lift span was achieved by a new design implementing a stretching screw for the first time. This allowed for small adjustments of the connection length. The stretching screw was then attached to the ropes by shackles. It is noteworthy that this design only allowed for one rope to be attached to each corner of the lifting span. The result being that there was no redundancy in the design should one of the ropes fail.

In 2006 the entire movable span was removed and replaced with an aesthetically similar truss span arrangement with a SLT deck.

Figure 5.41 View of sealed lift span deck after replacement in 2006

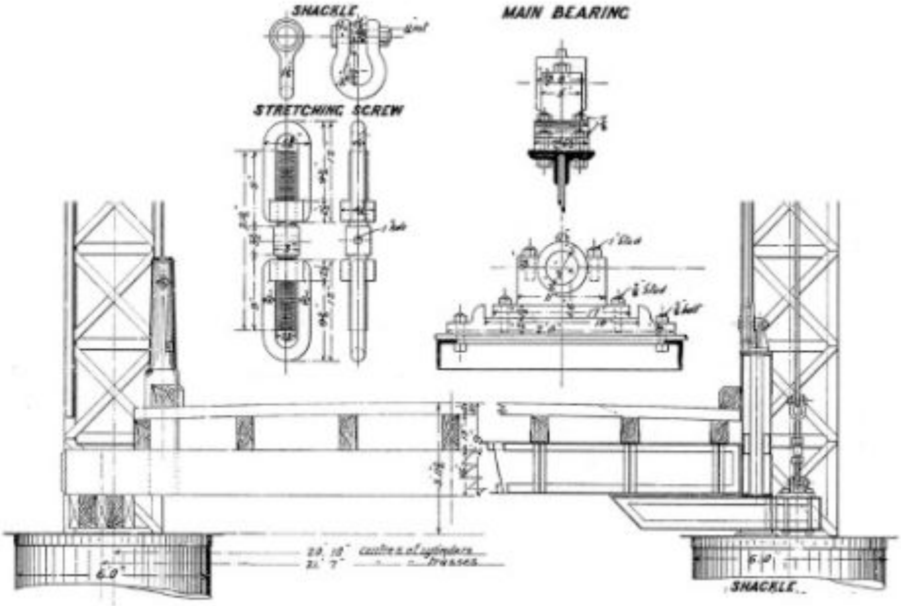


Figure 5.42 Original cross section and stretching screw for the Hinton lift span

Counterweights

NO significance.

The balance weights of the system were hung on the longitudinal sides of the lifting towers and consisted of cast iron with adjustable lead ingot filling. The balance weights ran along angles that were bolted to the two edges of the lattice tower facing the weights.

As with the Swan Hill Bridge design, the arrangement of having the balance weights on the outside of the tower had two advantages. The first was a reduction in friction compared to positioning the weights inside the tower. The second advantage was that this arrangement allowed for the sheaves to be mounted on the centre line of the towers thus eliminating eccentricities.

The counterweights were removed in 1949.

Sheaves and winch mechanism

The form and fabric of the sheave and winch components is of EXCEPTIONAL significance.

The sheaves consist of cast iron rims and wrought iron spokes. The sheaves were also reoriented back to the longitudinal direction, facilitating an even lift using ropes as the control mechanism.

Prior to this bridge, sheaves were interconnected by longitudinal and transverse drive shafts, as per the Swan Hill Bridge design by Percy Allan. Although there were no issues noted with the operation at Swan Hill, earlier designs such as the Tocumwal and Wilcannia Bridges designed by J. A. McDonald had issues with the longitudinal shafts pinching due to deflecting bracing girders. It is likely that the design by E. M. De Burgh was an attempt to eliminate this issue altogether by removing the longitudinal shafts.

The winch mechanism consisted of a manually operated handle at deck levels which drove a number of gears (Figure 5.43) before rotation was transferred by a vertical shaft to the sheaves and secondary gearing mounted at the top of the tower.

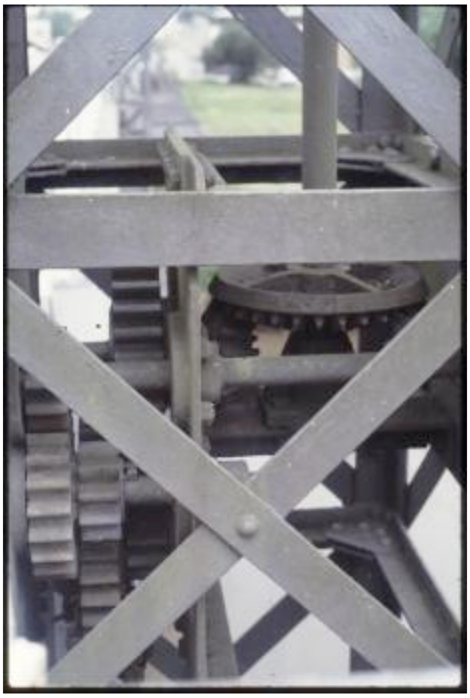


Figure 5.43 Hand operated winch mechanism (Source: RMS)

Mechanical components

The form and fabric of the mechanical components is of EXCEPTIONAL significance.

The lifting mechanism of the Hinton Bridge was another progression in vertical lift bridge designs. Hinton Bridge's mechanism implemented wire ropes that longitudinally connect the sheaves thus ensuring a uniform raise of the span during operation. This design was previously adopted in the modifications at Brewarrina in 1895, however this arrangement had not been included in the original design of the bridge.

The driving lift control is provided by a combination of wire ropes and shafts. The winch mechanism located at the base of the tower turns bevelled gears to a vertical shaft reaching up to the top of the tower. The direction of rotation is then transferred by a pinion into the mitred rim of the first sheave causing rotation, thus lowering the balance weight and lifting the span that is linked by the wire ropes.

The uniform transfer of driving force to all sheaves is provided by the implementation of transverse shafts and the wire rope arrangement in the longitudinal direction. Starting from the lifting span connection the wire ropes pass around the sheaves and cross longitudinally along the vertical span. After which the ropes pass over the sheave at the opposite end of the span and attach to the counter balance weight. The arrangement is highlighted in Figure 5.44.

Winch handle was removed sometime around 1949.

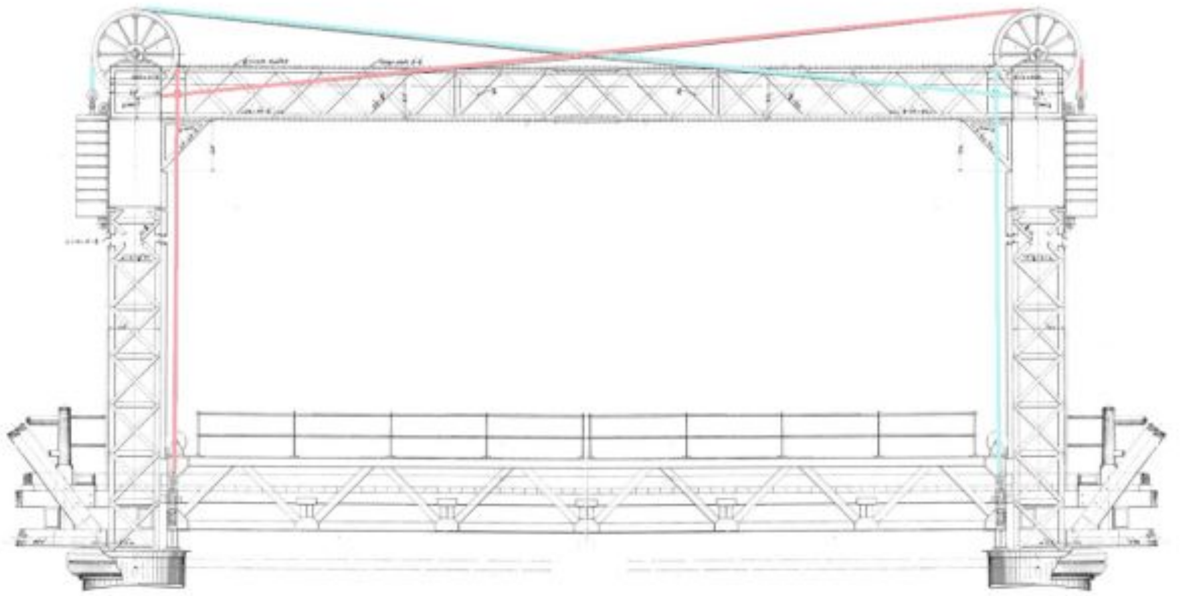


Figure 5.44 Mechanical arrangement implementation on Hinton Bridge

Vehicle and pedestrian barriers

NO significance.

Vehicle and pedestrian barriers were never installed on Hinton Bridge.

Ropes

NO significance.

Removed around 1949.

Motors and electrical

NO significance.

Motors and electrical components were never installed on Hinton Bridge. It remained manually operated throughout its serviceable life.

Actions required in order to restore the bridge to lifting operation

- Reinstate wire ropes.
- Overhaul mechanism.
- Reinstate guide rollers on movable span.

Summary of heritage assessments

The significances of each bridge component are summarised in the table below.

Table 5-9 Hinton Bridge - Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL
Movable Span	LOW
Counterweights	NO
Sheaves and winch mechanism	EXCEPTIONAL
Mechanical components	EXCEPTIONAL
Vehicle and pedestrian barriers	NO
Ropes	NO
Motors and electrical	NO

5.5 COBRAM BRIDGE

(Hinton Type, built 1902)

5.5.1 Description of the Bridge

Cobram Bridge is a timber truss, lift-span bridge generally two lanes wide, across the Murray River at Barooga. The bridge consists of a wrought iron vertical lift span with length 17.6 m (58 ft.). two composite timber and steel De Burgh truss spans with length approximately 31.7 m (104 ft.) and five timber beam spans with lengths ranging from 9.1 m (30 ft.) to 10.6 (35 ft.). The bridge is generally two lanes wide and has a clearance over normal water level of 7.9 m (25.9 ft.) when the lifting span is closed and 14.3 m (46.9 ft.) when the lifting span is open. The separate components that make up the Bridge are shown in Figure 5.45.

Figure 5.45 General view of Cobram Bridge (Source: RMS)

Development of roads and transportation in the Cobram region

Charles Sturt was one of the first to explore the local region either side of the Murray River in 1838, finding fertile soil, abundant resources and a reliable water supply. George Hillas took advantage of the area and used it for wool growing by taking up the “Barooga” Station in 1847. An adjacent property “Boomanoomana” was acquired by William Hay in 1863, which he later subdivided leading to the development of the Barooga township.

Robert Beauchamp was the first holder of Cobram Station and the small township of Cobram was the result of servicing the area. The town grew steadily, though a school was not built until 1896.

Prior to construction of the Bridge, the only way to cross the river was by means of a ford during periods of low water, or by punt when the river was running. The punt was established upstream of Cobram town in 1889, but was only intended as a temporary measure while the residents on both sides of the River lobbied for the construction of a bridge.

Being a border town Cobram was conscious of the likely benefits, which might accrue if it could become a centre of trade for both sides of the river. From 1889 to 1891 Cobram was involved in a struggle with Tocumwal to obtain a bridge (Martindale 1965: 19). Although it had no railway Tocumwal won the battle and a bridge was constructed there in 1895.

Design and construction

Following years of local agitation a design was prepared by the NSW PWD engineer in 1900. The design was in keeping with previous Murray River crossings; while a high-level bridge would be ideal, the combination of expensive river spans and long approach viaducts graded to suit horses and bullock- drawn drays made this option too costly. The affordable alternative was low-level bridges with movable spans.

The tender for construction was won by the Victorian bridge building firm Farquharson which was familiar with the design having previously built the lift bridges at Swan Hill and Tocumwal. The cost of the bridge was approximately £17,828 and was defrayed by the Government of Victoria, however the bridge approach and extensive earthworks was borne by NSW at a cost of £4,779 (PWD AR 1903).

At least one workman lost his life during the construction of the Bridge. The man, James Wainwright, a local resident, died when he fell from the Bridge into the River. The accident was reported in the *Cobram Courier* thus:

Wainwright was engaged in wheeling sand in a barrow to ballast the pier cylinders, and had to cross a plank and then tip his load from off a platform into the cylinder. He had safely traversed the plank and emptied his load when, in stepping back to let another man pass with his barrow he evidently misjudged his footing and fell backwards into the river. A lad who was holding a light for the men to see by at once rushed to the bank, obtained a boat and rowed to the spot where [the] deceased fell, but no trace of him could be found. Wainwright, who is said to have been a fair swimmer, was heard to cry for help when about 50 yards away from the bridge, and it is assumed that in falling from the bridge he was struck by the wheelbarrow, which accounted for his temporary silence. A prolonged search was made along the river but the darkness of night hampered the searchers, and their efforts proved unavailing (*Cobram Courier* 29/8/1901).

The Bridge was opened for traffic in October 1902 though the official opening ceremony was performed by William Davidson, Inspector General of Public Works for Victoria and took place on the 3 December 1902 (Martindale 1965: 21). Upon its completion the bridge provided a valuable link on the Tocumwal to Mulwala road which is now the Murray Valley Highway (NSW Heritage).

Operational history

The lift span of the bridge was last raised in 1974. The span was subsequently locked in position by extending the timber decking over the joints in the movable span (RTA bridge file 34.1112, part 2). Paddle steamers still operate near the bridge though these are sufficiently small in size to pass underneath the decks of the two adjacent bridges; they effectively mark the head of navigation for anything taller.

Maintenance history

Once completed, the Victorian Country Roads Board was responsible for maintenance of the Bridge. Correspondence on the bridge file between the Country Roads Board and the NSW Department of Main Roads during late 1936 discusses the future transfer of maintenance responsibility to the DMR, with the maintenance costs to be split between the two states. The Bridge was formally handed over to the DMR on 4 June 1937 (RTA Operations 2001).

In 2002 as a response to the increased needs of road users, VicRoads and the NSW Roads and Traffic Authority produced a *Murray River crossings strategy* which proposed the construction of new fixed span bridge at Cobram and the demolition of the lift span bridge. Complete loss of the old bridge was strongly opposed by the Victorian and NSW National Trusts, and Heritage Offices among many others, and complete retention was advocated. Through a cooperative and inclusive approach by all parties, especially the Engineering Heritage Committee of Engineers Australia, a balanced approach was reached whereby the spans in the river of the lift bridge would be retained though the timber beam approach spans could be removed without reducing the heritage value of the bridge. This was codified into the approval conditions from Department of Planning for the construction of the new bridge built in 2006 adjacent to and upstream of the original bridge, and named Cobram Barooga Bridge. This new bridge was built to a cost of $9.6 million. The Cobram lift bridge has been retained in service as a pedestrian bridge only since this time.

Figure 5.46 Horizontal separation between the lift bridge and the new concrete bridge built in 2006

The truss and lift span of the bridge are largely unchanged though four timber beam approach spans were removed from the NSW side of the bridge in 2010. The last approach span was then fitted with a stairway allowing pedestrian access to the bridge. I-girders have also been fitted to the approach to act as struts to buried concrete anchors. This addition acts as a modified abutment and provides lateral stability to the bridge.

Figure 5.47 Access platform for pedestrian access to Cobram

5.5.2 Statement of significance

Cobram Bridge was completed in 1902 and is of State significance owing to its form, setting and materials. The presence of the lift span is important. It is a unique type in the Murray River Crossing in the combination of materials and lift span. It played an important role in the local road network and remains an important transport link for local communities.

Source: RTA

Built in 1902, the Murray River lift-span bridge near Cobram is historically, scientifically, socially and aesthetically significant at State level. It is a large twelve-span bridge of timber, steel, iron and concrete, and features a steel lift-span on an iron and concrete substructure, with two large De Burgh composite timber-steel truss spans (modelled on the American Pratt pattern) one on each side of the steel lift span. The De Burgh (Pratt) composite timber-steel trusses which are such an important and attractive element in the structure, were built only for a brief period between 1900 and 1904, and were largely displaced by Dare's version of the composite steel-iron-timber Howe Truss on NSW. Public Works projects after 1905. The Murray River has another bridge sharing similar features, at Koondrook-Barham, but this pair of bridges are extremely rare in the broader Australian context, and nothing like them exists south of the Murray. The Cobram Bridge's steel lift span represents the peak in evolution of New South Wales lift-span technology associated with leading Sydney bridge engineer, Percy Allan.

It is a monument to the engineering abilities of Allan and E M De Burgh at Sydney, and the construction skills of the prolific Victorian bridge-building firm of Farquharson which constructed many famous large river bridges: Chinaman's Bridge and the old Seymour highway bridge on the Goulburn River, and a series of Murray River bridges including superb existing lift-span and/or truss bridges at Swan Hill, Tocumwal, Cobram and Howlong, and other timber truss bridges long gone like the old Albury Bridge and the Tintaldra Bridge.

For many decades the big river bridge has played a very important social role in linking the Riverina centre of Berrigan, and isolated residents of the smaller New South Wales river land settlement and district of Barooga, directly with Cobram and Shepparton in north-central Victoria. Built in the era of Australian federation, the bridge was seen from its beginnings as an important physical symbol of the creation of a national Australian society out of disparate colonial social components. Its special social importance to settlers on the Victorian side on the Murray River is suggested by the rare situation that this bridge, which is officially New South Wales property, was built entirely from Victorian funds. Aesthetically the Cobram lift-span bridge and its forest context have changed little from what they were early this century. Strengthening of some of its timber-beam-span substructure by the addition of some steel components is not readily visible to the passer-by. Its unusual combination of a tall steel lift span along with heavy timber components of the lengthy De Burgh composite-truss spans on either side, plus lengthy timber beam approach spans at either end, is visually striking. The bridge links Cobram and Barooga, but is situated on a broad stretch of Murray River floodplain, within a picturesque rural context of spreading red-gum trees belonging to the Barooga State Forest.

Source: Victorian Heritage Database

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Not listed
OEH Heritage Division State Heritage Register	To be listed
Victorian Heritage Register	Listed
Berrigan Shire Council Local Environmental Plan, 2013	Not listed
NSW National Trust Register	Listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications

In summary, modifications were made to the transverse girder creating a more aesthetically pleasing truss. Dual ropes with compensating bracket were adopted to increase redundancy in the system.

Table 5-10 Cobram Bridge modifications

Preceding Designs	Issues with Design	Evolution at Cobram
Portal frame of lift tower.	N/A.	Aesthetically pleasing curved end design implemented with plates of date and state.
Single wire rope adopted for each corner of lift span.	No redundancy in system.	Dual ropes adopted to support each corner of the lift span.
Connection by bracket and ferrules.	Does not ensure even distribution of loads to all ropes.	Compensation bracket adopted for connection design.

5.5.3 Description of lift span mechanism components

Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance

The Cobram Bridge is a further improvement on E. M. De Burgh's previous design for Hinton Bridge. The towers of the bridge consist of a wrought iron lattice type structure with a square top section made of wrought iron plating (Figure 5.48 to Figure 5.50). Following on from preceding designs, the tops of the towers are restrained longitudinal lattice girders, transverse plated truss girder and wind bracing. The transverse girder is an aesthetically pleasing improvement on the previously adopted lattice girders.

The longitudinal lattice girders are aligned to the towers and gusset plates have been adopted at the connection of the longitudinal lattice girders. These act to increase the overall stiffness of the towers and further minimise deflections.

Figure 5.48 Photo of lattice towers in 2013 (Source: RMS)

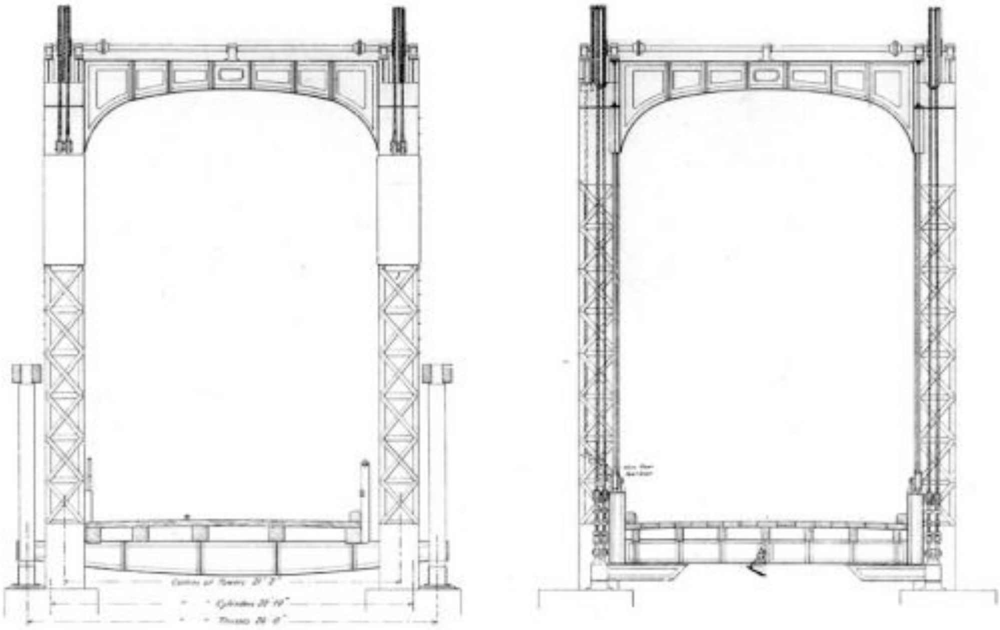


Figure 5.49 Drawing of lattice towers elevation and section

Movable span

The form and fabric of the movable span is of MODERATE significance.

The movable span consists of two main longitudinal Warren type trusses supporting steel plate web cross girders. The stringers are of sawn timber construct that finally supports the timber decking (Figure 5.51). The trusses were strengthened by welding steel beams along the top and bottom chords in 2001.

Figure 5.50 Side view of movable span; the steel beams attached in 2001 for reinforcement have corroded noticeably

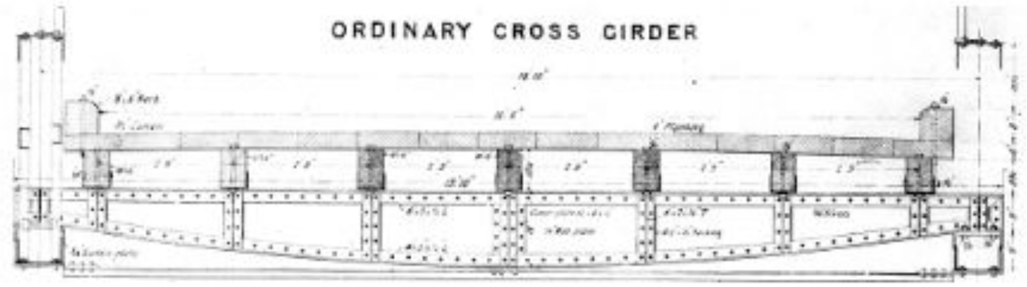


Figure 5.51 Cross section for the Cobram Bridge lift span

The adoption of dual wire ropes was a significant improvement on the Hinton Bridge design as it introduced redundancy into the system. The connection between the wire ropes and the lift span is achieved by a similar design to Hinton, namely by implementing stretching screws, thus allowing for small adjustments of the connection length. The connection system also incorporated a small yet striking improvement that consisted of using a compensation bracket that would ensure even distribution of loading between the ropes (Figure 5.52).

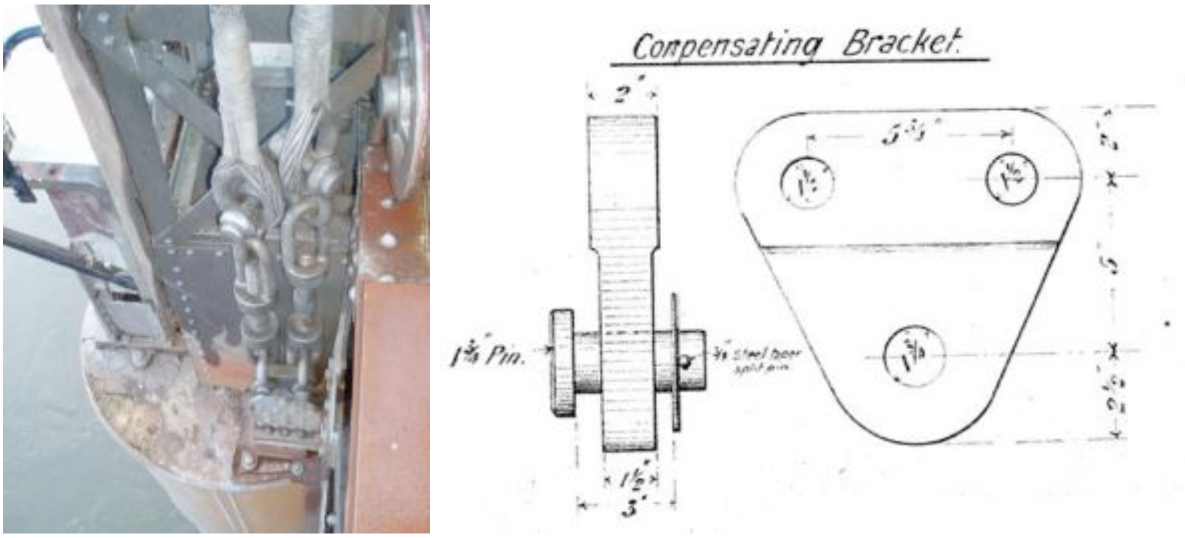


Figure 5.52 Compensating bracket for Cobram Bridge (Source: RMS)

Counterweight

The form and fabric of the counterweight is of MODERATE significance.

The balance weights of the system are hung on the longitudinal sides of the lifting towers and are made up of cast iron with adjustable lead ingot filling. The balance weights roll along angles that are bolted to the two edges of the lattice tower facing the weights (Figure 5.53).

As with the Hinton Bridge design, the arrangement of the counter balance weights on the outside of the tower has two advantages. The first was a reduction in friction compared to positioning the weights inside the tower.

The second advantage was that this arrangement allowed for the sheaves to be mounted on the centre line of the towers thus eliminating tower loading eccentricities.

Figure 5.53 Cobram counterweights (Source: RMS)

Sheaves and winch mechanism

The form and fabric of the sheaves is of MODERATE significance.

The sheaves consist of a cast iron rim with the spokes keyed into them. The sheave adjacent to the driving mechanism is also fitted with a rack to allow from the pinion to drive motion to the system. The winch mechanism is mounted at deck level and operated by hand (Figure 5.54).

Figure 5.54 Cobram Bridge winch mechanism (Source: RMS)

Mechanical components

The form and fabric of the mechanical components is of MODERATE significance.

The lifting mechanism is similar to the one used in the Hinton Bridge design. The driving control is still provided by a combination of wire ropes and shafts. The winch mechanism is located at the base of the tower that turns bevelled gears to a vertical shaft reaching up to the top of the tower. The direction of rotation is then transferred by a pinion into the mitred rim of the first sheave causing rotation, thus lowering the counter balance weight and lifting the span that is joined to the wire ropes.

The uniform transfer of driving force to all sheaves is provided by the implementation of transverse shafts and the wire rope arrangement in the longitudinal direction (Figure 5.55).

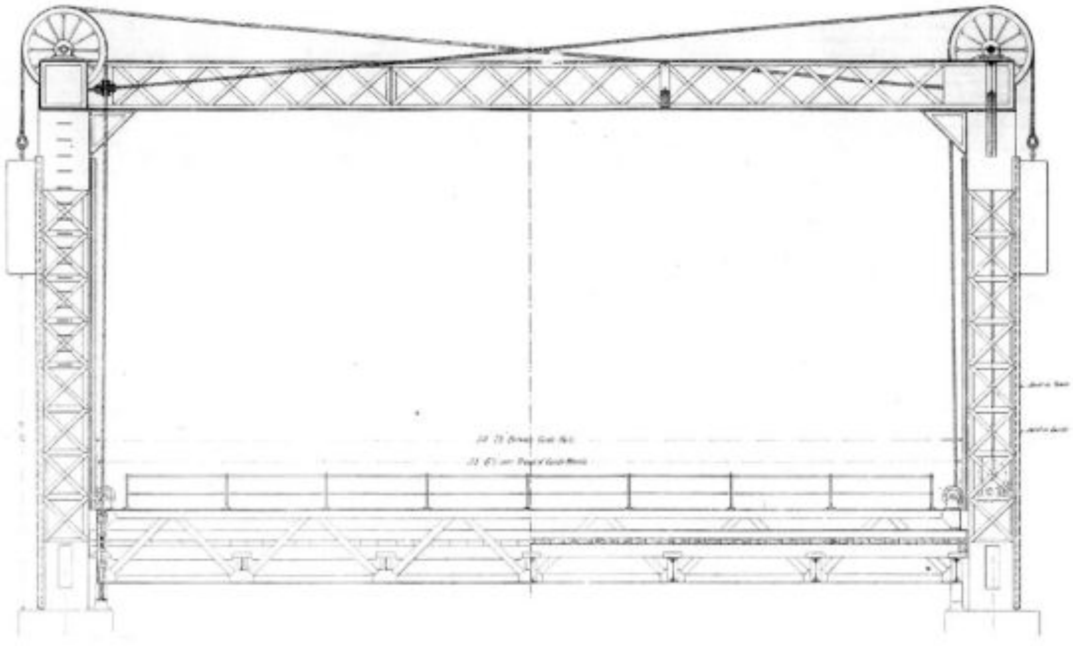


Figure 5.55 Elevation of Cobram Bridge

Vehicle and pedestrian barrier

The form and fabric of the vehicle and pedestrian barriers is of NO significance.

In addition Cobram Bridge was originally fitted with manually operated safety gates located either side of the movable span. These gates have since been removed from the Bridge.

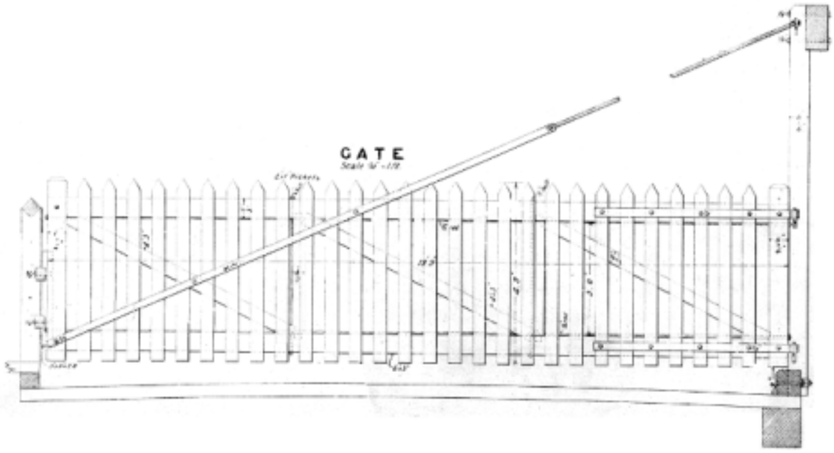


Figure 5.56 Gate on Cobram Bridge

Ropes

The form and fabric of the ropes is of LOW significance.

The wire ropes are an important component of the lifting mechanism. Starting from the lift span, the wire ropes pass around the sheave and cross longitudinally along the vertical span. After which the ropes pass over the sheave at the opposite end of the span and attach to the counter weight. The rope arrangement as described above only relates to one of the wire ropes connected to a corner of the lift span. The second rope at each corner simply travels from the lift span up and over the sheave and directly down onto the counter weight. This allows for increased redundancy without complicating the arrangement of the longitudinal wire ropes. The ropes can be distinguished as either haul ropes or counter weight ropes.

Motors and electrical

NO significance.

Motors and electrical components were never installed on Cobram Bridge. It remained manually operated throughout the initial period of its operation. Subsequently a portable motor has been used to drive the opening mechanism of the bridge. RMS brings the portable device to site in order to raise the bridge.

Summary of heritage assessments

The significances of each bridge component are summarised in the table below.

Table 5-11 Cobram Bridge - Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL
Movable Span	MODERATE
Counterweights	MODERATE
Sheaves and winch drums	MODERATE

Mechanical components	MODERATE
Ropes	LOW
Vehicle and pedestrian barriers	NO
Motors and electrical	NO

5.6 BARHAM BRIDGE

(Hinton Type, built 1899)

5.6.1 Description of the Bridge

The Bridge over the Murray River at Barham consists of a wrought iron vertical lifting span with length 58 ft. two composite timber, wrought iron and steel De Burgh truss spans with length approximately 104 ft. and two timber beam spans with lengths of 30 ft. each. The bridge is largely two lanes wide and has a clearance over the normal water level of 49 ft. when the lift span is open.

The upper framework of the lifting span consists of four wrought iron lattice towers with longitudinal wrought iron lattice girders and transverse plated truss girder connecting the towers at the top. The supports of the lift span comprise of two piers made from pairs of tubes fabricated from curved and shaped wrought iron plates riveted together, and joined with cross ties forming elliptical holes for improved aesthetics. The piers then continue as cast iron concrete filled tubes below the waterline. The two approach spans are De Burgh trusses consisting of a steel bottom chord, vertical timber posts and diagonal steel tension members.

Figure 5.57 General View of Barham-Koondrook Bridge

Development of roads and transportation in the Barham region

The original settlement of Barham was typical of numerous other towns along the Murray River. Their development is attributed to being those sites where deep water allowed for river ports and also the regions where the river could be readily crossed (Painter 1993:13). Barham is the result of the first lease taken up in the western Wakool region. It was acquired by Edward Green, who named the property 'Barham' after his wife's family (Grant 190: 44).

Early settlers mainly consisted of pastoralists moving north from Victoria that primarily used the land for wool production and by 1850 most of the better river locations were occupied by these squatters (Heritage Office 1996: 149). Gold rushes during the 1850s shifted the land usage from wool production to beef cattle farming in order to meet the high demand from increased rural populations. However this shift was short lived and by the 1860s the wool industry dominated once again (HO 1996: 150). The dominance of wool continued until the 1890s when production of wheat increased dramatically. Finally in July 1893 a site for the township of Barham was surveyed and the first lots were sold (*Border Journal*, 1986: 39).

South of the Murray River, Koondrook became important for timber production and the port was heavily reliant on the local saw mill. It was commented that the 'streets were paved with sawdust' (Painter 1993: 69). Due to the increase in economic activity and local population the passage at Barham became an important link between southern parts of New South Wales and northern Victoria (Grant 1970: 15). Prior to the construction of the bridge a punt served as the only local crossing over the river (Figure 5.58). The punt was considered to be too inconvenient and unreliable due to its limited operating hours and old age, as it was previously used at Echuca for 30 years before being moved to Barham. Furthermore pastoralists would avoid the crossing as usage frequently decreased the value of stock due to "knocking about" (McConnell *et al* 1994: 11, 15).

Figure 5.58 Punt unloading cattle at Barham-Koondrook (Source: Grant 1970)

Design and construction

The lobbying for a bridge at Barham commenced in the 1890s and in June 1900 the PWD engineer E. M. De Burgh took evidence at Kerang and Koondrook in reference to "the matter" (McConnell et al 1994: 11). It was found that there were at least 200 new settlers within a 50 mile radius of Barham and Koondrook hence the area was an ideal outlet for the produce. Furthermore due to the absence of a bridge, produce was transported across the river approximately 90 km upstream at Swan Hill 90 km downstream at Echuca (McConnell et al 1994: 11).

Tenders for the construction of a "steel lift bridge on the Murray River at Barham and Koondrook" were called for in the NSW Government Gazette on the 10th of March 1902. The original contract seems to have been secured by Monash and Anderson, who later withdrew, but then appear to have won the final contract when fresh tenders were called for in November of the same year (McConnell *et al* 1994: 11, 15). The Bridge was under construction by June of 1903, with funding provided jointly by NSW and Victoria (*RDPW* 1903: 8). The timber for the bridge was obtained from the northeast coast of NSW with the raw material for the wrought iron and steel coming from Scotland and structural members fabricated in Ballarat at the Eureka Iron Works (McConnell et al 1994:13).

The cost of the bridge was approximately £11,358 and the payment was covered by both the New South Wales and Victorian Governments. On the 8th of October 1904 the bridge was officially opened with a number of Federal and State members attending the event (Figure 5.59). The opening ceremony and banquet were apparently well attended; the enthusiasm of the spectators was such that a crowd of people rushed across the lift span before it had completely closed, causing one of the cogwheels in the lifting gear to break. The lifting gear was shut down for a number of days while a replacement wheel was obtained (McConnell *et al* 1994: 17).

Figure 5.59 Lift span raised during the official opening of Barham Bridge in September 1904 (Source: University of Melbourne Library)

Figure 5.60 Lowering of lift span in 1985

The Barham Bridge was designed by engineer E. M. De Burgh with construction completed in 1904. The design is an adoption of his previous design of Cobram Bridge and as with Cobram, the design incorporates further improvements on the Hinton and Murwillumbah Bridge designs.

The Barham Koondrook community turned out to acknowledge the centenary of the bridge's opening in 2004 by organising festivities with the bridge as a focus and commemorative a banner was hung from the lift tower. A decorative picket gate was put in place on the deck; this was the original form (see Figure 5.61) later replaced with the existing tubular steel gates.

Figure 5.61 **Decorative gate set up on bridge for Centenary celebrations, 9th and 10th October, 2004**

Operational history

As with other later movable span bridges (post 1900), the Barham Bridge lift span was used relatively infrequently as river trade, by the period of its construction, was on the decline (Fraser, 2005). Test lifts have been made at regular intervals but accurate records of operational lifts have never been kept.

From the 1990s after more than ten years of drought and a low Murray River, river traffic was at a minimum and the high clearance under the bridge resulted in very few lift requests from river boats or paddle steamers. The lift span remains in regular but infrequent use.

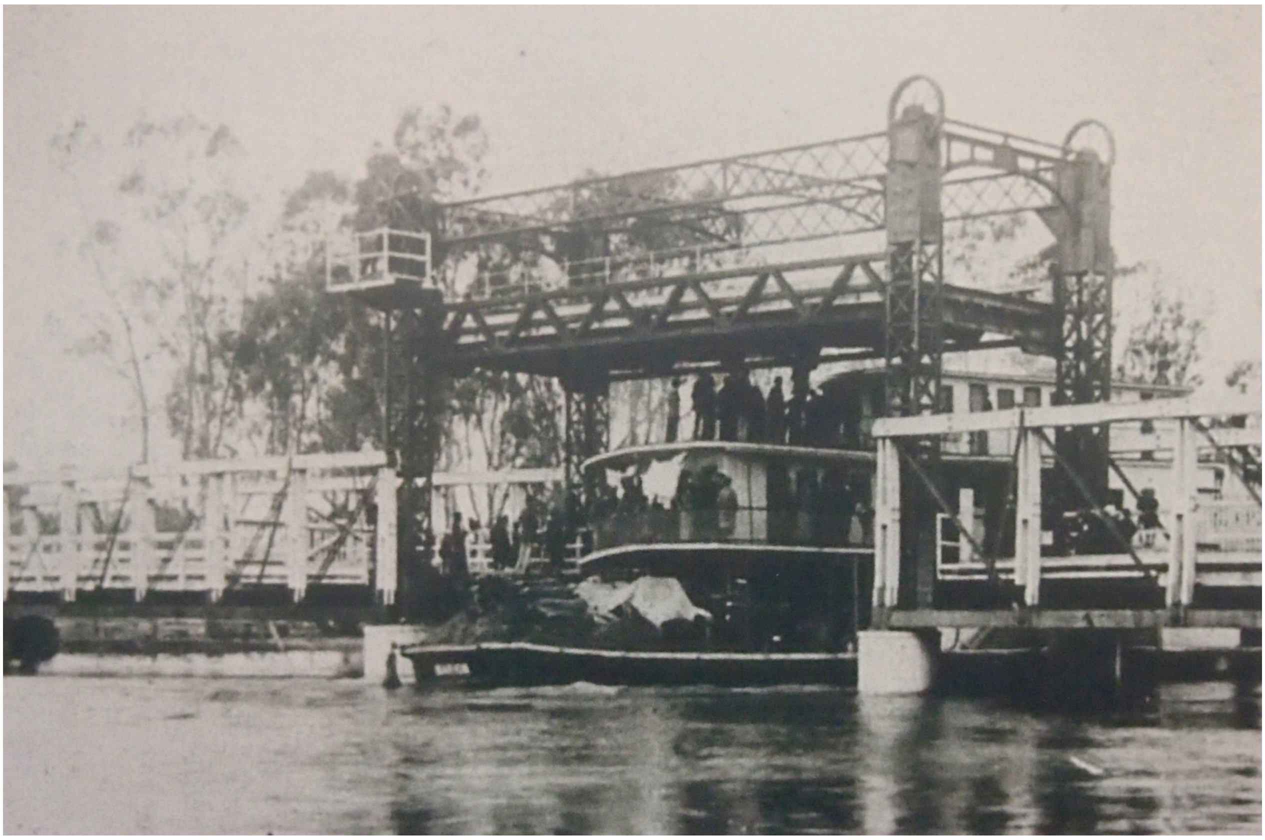


Figure 5.62 Lift span raised c.1900 (Source: Barham Bridge Centenary Committee)

Figure 5.63 Lift span raised to full height in 1985 during a flooding event (Source: RMS Bridge File)

Maintenance history

Under the bridge building agreement, the cost of the maintenance of the bridge, like the cost of the bridge building, was shared by NSW and Victoria. The replacement of the lifting gear cogwheel after the 1904 opening ceremony was the first maintenance work required on Barham Bridge. Damage was done to the decking of the bridge some ten years later. The wheels of a heavy traction engine broke through the decking causing the vehicle to be stuck and closing the bridge to vehicular traffic for a day (McConnell 2001: 48).

In 1918 drawings of proposed modifications to the lifting mechanism were prepared by the Public Works Department. These modifications consisted of the introduction of an additional 2 metres of lift tower with vertical shafts and bevelled gears to enable the operating winch to be worked from the deck level. It is noteworthy that the two vertical lift bridges constructed at Tooleybuc in 1925 and Abbotsford in 1928 adopted the older Swan Hill design as a basis. This suggests that the E. M. De Burgh design was not universally accepted within the PWD.

In 1935 the NSW Department of Main Roads took over responsibility for bridge maintenance from the Department of Public Works (RTA file 469.1311, part 1). RTA bridge maintenance files include documents dating from 1928; the following is a summary of the maintenance history of the bridge as extracted from those files.

Table 5-12 Barham Bridge – Summary of maintenance history

Date	Description	Cost
1923	Height of lift span towers increased by approximately 2 metres	n/a
1927	Shire of Kerang requested the use of the Bridge for carrying electric cables from the electric generating plant at Barham.	n/a
1928	Decking renewed, steelwork repainted, tarring.	£665
1932	Longitudinal running strip recommended. This necessitated adjustment of the lifting gear by loading with concrete blocks.	Est. £282
1950/53	New lifting gear required – manufactured by DMR central workshop.	Est. £520 for lifting gear.
1973/75	Steel bridge inspection report – steel bottom chords in span 3 badly corroded, tower bases on piers 2 and 3 rusting inside, lift span weights should be balanced, lubrication needed.	Est. $9,105
1979	Lift span jammed – shaft and bearing to be replaced.	
1980/82	Decking and longitudinal sheeting on lift span and spans 1 and 2 renewed. New counterweight plates to be added to the lifting mechanism.	
1987	All timber stringers supporting lift span deck replaced with steel I-girders.	
2000	Lift span towers strengthened through welding additional	

Date	Description	Cost
	plate sections to the top chords and relocating the iron railings.	

Figure 5.64 Sheave wheel testing on Barham Bridge

Figure 5.65 Repair works on Barham Bridge

The bridge deck was re-surfaced with a bitumen overlay in mid-2006 (Figure 5.66).

Figure 5.66 Image of re-surfaced bridge deck (Source: RMS)

5.6.2 Statement of significance

Built in 1904, the Barham Bridge is historically, scientifically, socially and aesthetically significant at State Level. It is a complex seven-span structure of timber, steel, iron and concrete, featuring a steel lift-span on an iron and concrete substructure, and two large De Burgh composite timber-steel through-truss spans (modifying the American Pratt pattern) one at either side of the main lift span.

The De Burgh (Pratt) composite timber-steel trusses which are such an important and attractive element in the structure, were built for only a brief period between 1889 and 1904, being largely displaced by Dare's new version of the composite steel-iron-timber Howe Truss on NSW. Public Works projects after 1905. For this reason alone, the loft bridge at Barham-Koondrook is a rare item. The use of a steel lower chord in these composite trusses permitted longer span lengths on broad river channels, than had been normal with standard timber-truss designs.

This bridge was among the last of the New South Wales lift-span bridges to be constructed, near the end of the main steam-boat era. The steel lift span represents the peak in evolution of New South Wales lift-span technology associated with the leading Sydney bridge engineer Percy Allan. This bridge survives as a proud monument to the design abilities of the prominent Sydney engineers Allan and De Burgh and the Victorian bridge-construction skills of Monash and Anderson.

The Barham Bridge is also of considerable social significance. It has played a vital role for over ninety years in linking the twin settlements of Koondrook and Barham, which would otherwise be separated by the Murray river. These little river land townships operate as one social entity. The bridge has also played a very important role in linking Riverina centres like Moulamein and the Wakool irrigation area to Victorian centres such a Kerang. For many decades the bridge directly connected the Wakool area with the Victorian rail-head at Koondrook and it has long been an important link in a major north-south stock-route connecting Queensland and New South Wales pastoral centres with Victorian markets.

The Barham-Koondrook Lift Bridge is aesthetically significant. It is situated in timbered reserve amidst river red gums at a relatively high site on the Murray River floodplain, immediately past the western end of Gunbower Island. This floodplain context reminds the viewer of the district's long history as a centre for the timber trades. This bridge has changed very little from when it was built in the early years of this century. The combination of tall steel lift span and the heavy timbers of the lengthy De Burgh composite-truss spans on either side, is conspicuous and aesthetically appealing.

Source: Victorian Heritage Database

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Not listed
OEH Heritage Division State Heritage Register	Listed
Victorian Heritage Register	Listed
Wakool Shire Council Local Environmental Plan, 2013	Not listed
NSW National Trust Register	Listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications

In summary, modifications that were made to the Barham Bridge from preceding designs consisted of re-locating the winch mechanism from deck level to the top of one of the towers. The preceding design was reverted to in 1923.

Table 5-13 Barham Bridge – Summary of modifications

Preceding Designs	Issues with Design	Evolution at Barham
Winch located at deck level	Losses due to friction of vertical shaft and changes in rotational direction.	Winch re-located to top of tower, eliminating need for vertical shaft and bevelled gearing.

5.6.3 Description of lift span mechanism components

Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance.

The Barham Bridge is the final design of E. M. De Burghs and combines all the improvements of his preceding opening bridges along with a new modification to the lifting mechanism.

The towers of the bridge consist of a wrought iron lattice type structure with a square top section with wrought iron plating. Following on from preceding designs, the tops of the towers are restrained by the longitudinal lattice girders and transverse plated truss girder and wind bracing (Figure 5.67).

The alignment of the longitudinal lattice girders is aligned with the towers and gusset plates have been adopted at the connection of the longitudinal lattice girders. These act to increase the overall stiffness of the superstructure and minimise deflections during operation.

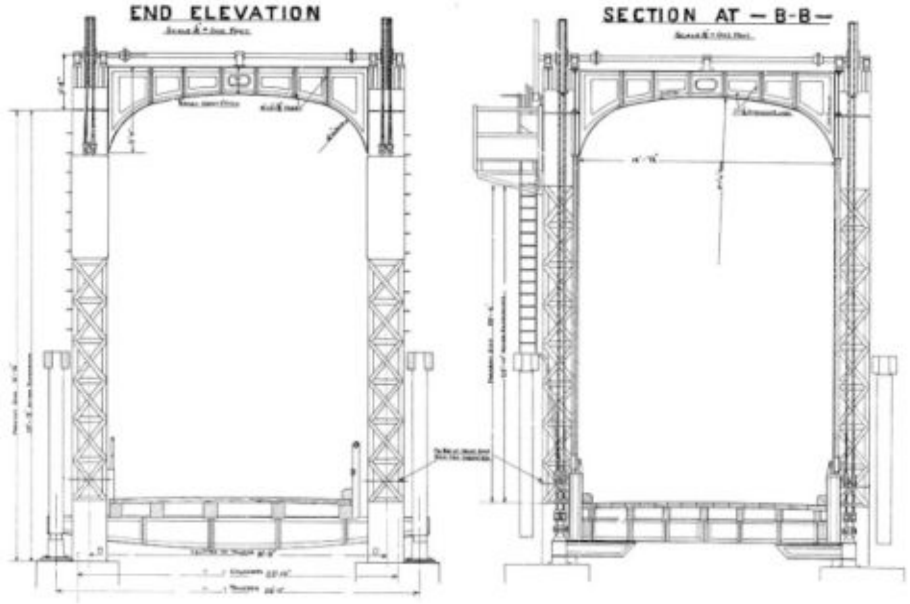


Figure 5.67 Drawing of towers on Barham Bridge

Figure 5.68 Date plaque on tower transverse brace member (Source: RMS)

Movable span

The form and fabric of the movable span is of MODERATE significance.

The lift span consists of two main longitudinal Warren type girders supporting steel plate web cross girders. The stringers are of sawn timber construct that support the timber decking (Figure 5.69).

The connection between the wire ropes and the lift span is achieved by a similar design to Cobram, namely by implementing stretching screws, thus allowing for small adjustments of the connection length. The connection system also incorporates a compensation bracket that ensures even distribution of loading between the ropes.

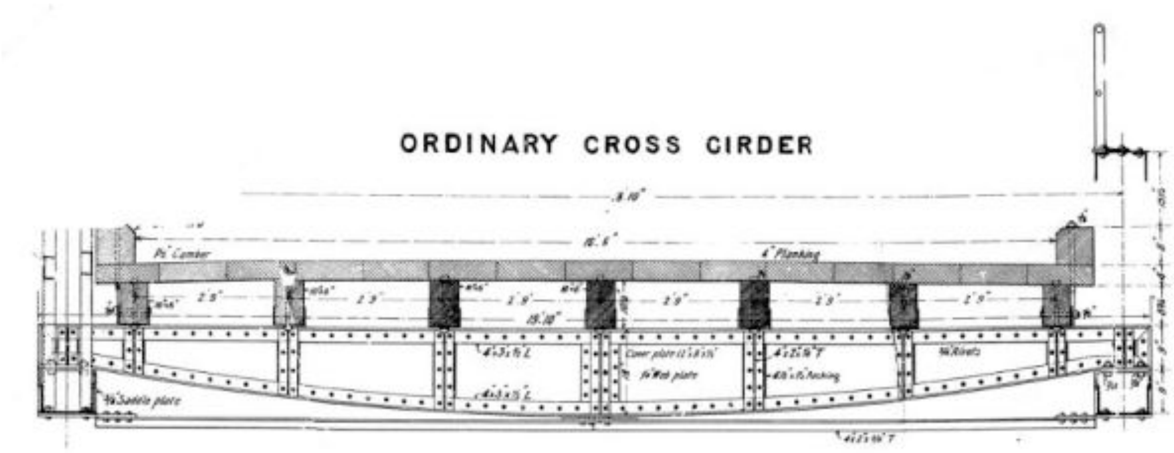


Figure 5.69 Cross section for the Barham lift span

Counterweight

The form and fabric of the counterweight is of MODERATE significance.

The balance weights of the system are hung on the longitudinal ends of the lifting towers and consist of cast iron with adjustable lead ingot filling (Figure 5.70). The balance weights roll along angle guides that were bolted to the two edges of the lattice tower facing the weights.

As with the Cobram design, the arrangement of balance weights on the outside of the tower has two advantages. The first was a reduction in friction compared to positioning the weights inside the tower. The second advantage was that this arrangement allowed for the sheaves to be mounted on the centre line of the towers thus eliminating loading eccentricities.

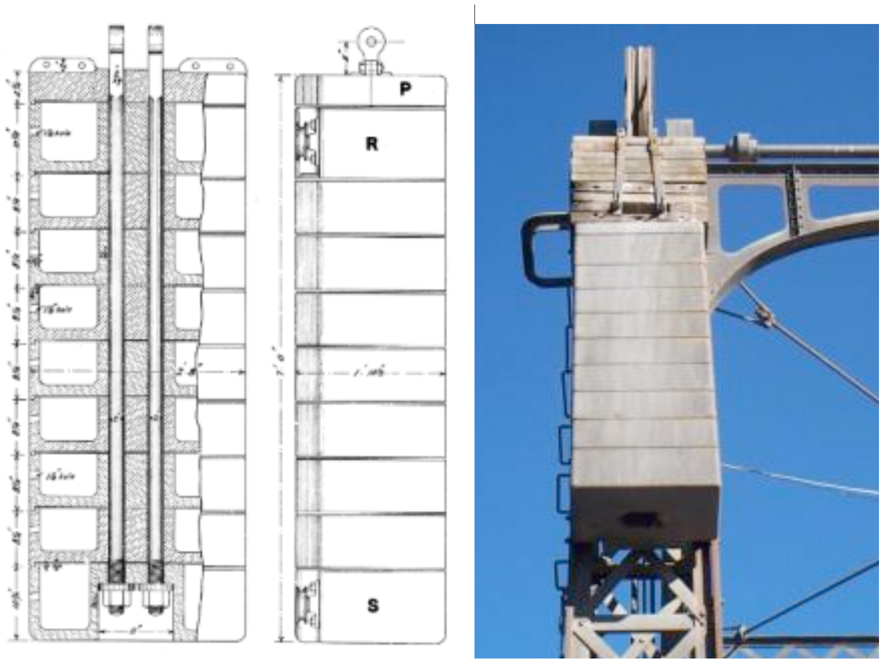


Figure 5.70 Barham Bridge Counterweights (Source: RMS)

Sheaves and winch mechanism

The form and fabric of the sheaves is of MODERATE significance.

The sheaves on Barham Bridge consist of a cast iron rim and hub joined by round bar spokes (Figure 5.71). The winch is mounted at the top of one tower and was driven by a fly wheel and handle.

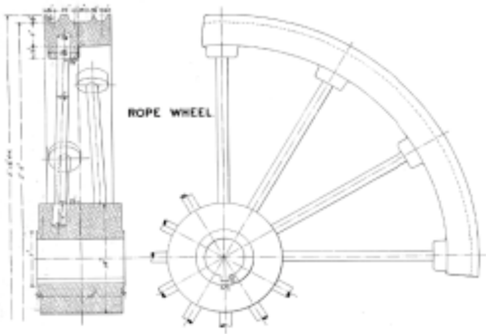


Figure 5.71 Drawing of sheaves adopted on Barham Bridge

Mechanical components

The form and fabric of the mechanical components is of MODERATE significance.

The lifting mechanism of the Barham Bridge is the final evolution of the old type vertical lift bridge designs. The majority of the design is the same as that adopted for the preceding Cobram Bridge, though modifications were made to the location of the winch, eliminating the need for a vertical shaft in the design (Figure 5.72).

The re-location to the top of the tower also has the advantage of not causing excessive deflections of the superstructure, as noted on the previous designs of J. A. McDonald at Mulwala and Tocumwal with a raised winch location. The driving control is provided by a combination of wire ropes and shafts. The winch mechanism is located at the top of the tower and it turns gears attached to the first transverse shaft. The rotation of this shaft causes the rotation of the sheaves, lowering of the balance weights and subsequent lifting the span. The uniform transfer of driving force to all sheaves is provided by the implementation of transverse shafts and the wire rope arrangement in the longitudinal direction (Figure 5.73).

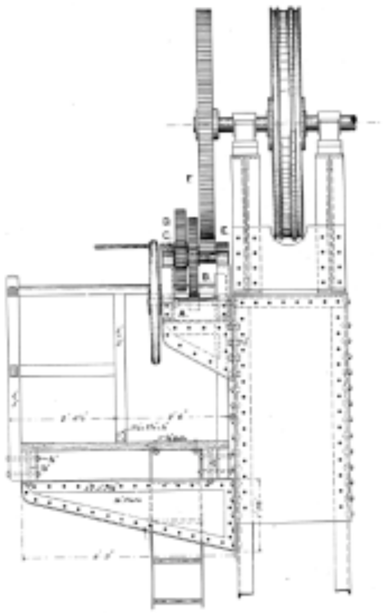


Figure 5.72 Drawing of winch, gearing and sheaves on Barham Bridge

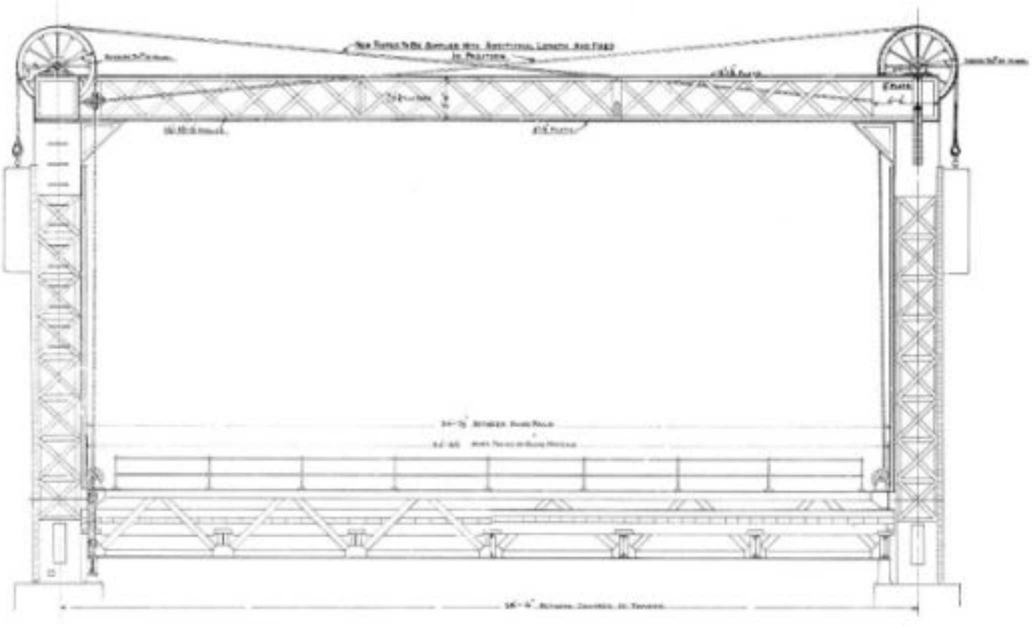


Figure 5.73 Elevation of Barham Bridge

Vehicle and pedestrian barrier

The form and fabric of the vehicle and pedestrian barriers is of LOW significance.

He manmade gates are similar to those adopted on Cobram Bridge were originally positioned either side of the movable span. These have since been removed and replaced with tubular steel gates (Figure 5.74).

Figure 5.74 Current pedestrian barriers either side of movable span

Ropes

The form and fabric of the ropes is of LOW significance.

The wire ropes are an important part of the lifting mechanism. Starting from the lift span attachment wire ropes pass around the sheave and cross longitudinally along the lift span. After which the ropes pass over the sheave at the opposite end of the span and attach to the counter weight. The rope arrangement as described above only relates to one of the wire ropes connected to a corner of the lift span. The second rope at each corner simply travels from the lift span up and over the sheave and directly down onto the counter weight. This allows for increased redundancy without complicating the arrangement of the longitudinal wire ropes. The ropes can be distinguished as either haul ropes or counter weight ropes. This arrangement is similar to that adopted at Cobram Bridge.

Motors and electrical

The form and fabric of the motors and electrical is of LOW significance.

Motors and electrical components were not originally installed on Barham Bridge. It remained manually operated throughout the initial period of its operation. Since 1997 a hydraulic motor has been used to drive the opening mechanism of the bridge. The motor is driven by a portable power pack (Figure 5.75).

Figure 5.75 Council officer with removable power pack to facilitate opening (Source: RMS)

Summary of heritage assessments

The significances of each bridge component are summarised in the table below.

Table 5-14 Barham Bridge – Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL
Movable Span	MODERATE
Counterweights	MODERATE
Sheaves and winch drums	MODERATE
Mechanical components	MODERATE
Vehicle and pedestrian barriers	LOW
Ropes	LOW
Motors and electrical	NO

5.7 TOOLEYBUC BRIDGE

(Swan Hill Type, built 1925)

5.7.1 Description of the Bridge

The Bridge over the Murray River at Tooleybuc consists of a wrought iron vertical lifting span with length 58 ft., two 71 ft. timber Allan truss spans and three timber beam approaches ranging from 28 ft. to 30 ft. The bridge is 18 ft. wide but reduces to 14 ft. at the lift span.

The upper framework of the lifting span generally consists of four wrought iron lattice towers with both transverse and longitudinal wrought iron lattice girders connecting the towers at the top. The supports of the lift span comprise of two piers made from a pair of circular reinforced concrete columns connected by a reinforced concrete diaphragm.

Figure 5.76 General View of Tooleybuc Bridge (Source: Victorian Heritage data base)

Development of roads and transportation in the Tooleybuc region

Tooleybuc Village was on the Puon Buon run, part of the pastoral empire of Ben Boyd, the whaling entrepreneur of Twofold Bay. During the 1850s Puon Buon was owned by William Degraves and then Christopher Bagot. In the 1860s the Trust and Agency Company ran 32,000 sheep there and later in the nineteenth century J. Lawrence held the property and ran 50,000 sheep. The high stocking was encouraged by the almost permanent lakes on Puon Buon. The area is situated on the western fringe of the saltbush plain, which is a semi-arid area created by sediments of the Murray-Darling flood waters. The saltbush provided useful fodder and the Murray River frontage was largely taken up by European settlers in 1847 (Willoughby, 1993).

The first crossing of the Murray River at Tooleybuc was established in 1847, where a punt and hotel were constructed on the Victorian side of the river. In 1855 the first punt vessel was replaced; two more vessels would be put to use on the crossing while it remained in use until 1924 (RTA File no. 469.1316).

The development of river transport and the growth of Swan Hill, Echuca and Mildura as major trade centres assisted in opening up the region for further settlement throughout the 1850-60s. The paddle-steamers obtained wood for the boilers from wood piles stacked at suitable places along the Murray. By 1860, documents show that a man named Tooleybuc Jimmy lived in a hut at this location – his job was apparently to ensure the wood pile was constantly well stocked (Willoughby, 1993). Overland coaches had also commenced travelling between Swan Hill and Euston by the 1860s, and their routes would likely have taken them through the Tooleybuc District

A riverside hotel (the Tooley Buc) was in operation in the 1860s on the NSW side (see Figure 5.77). The hotel quickly gained popularity and became a focal point for traffic through the region (Hickey 1992). In response a town covering 467 acres was surveyed in 1866, between Lake Coomeroop and the Murray River.

Development of the township of Tooleybuc was assisted by the subdivision of the huge station in 1914. The Tooleybuc area subsequently became the setting of intensive agriculture, with fruit-growing the principal cash crop.

Figure 5.77 Early artist's impression of the punt with hotel in background, c.1870s (Source: Ronald, 1960)

Design and construction

Campaigning for a bridge had started in the community by members of the Farmers and Settlers Association, spearheaded by their secretary Septimus Broomhead who repeatedly wrote to the government on this issue (Hickey 1992). As early as 1913 the local M.L.A., Mr. Doe had started to raise the issue in Parliament. Apparently he too became insistent on this matter that he was referred to as the "Minister for Tooleybuc" (*The Riverina Recorder,* 28/2/1924).

Following a close investigation, the two Governments agreed to a proposal with the arrangement being that New South Wales would contribute by preparing the plans and generally supervising the construction works. (DPW 1922:38).

The Border Railways Agreement was a large public works programme developed collaboratively between the NSW and Victorian State governments aimed at extending the existing rail network through northwest Victoria and the western Riverina. The purpose was to develop improved transportation links between rural producers and their markets. The extension of the Victorian Railway system beyond Swan Hill to Kooloonong made the matter of providing a bridge at Tooleybuc of high importance as the existing ferry service would clearly be insufficient. The old punt had been slow and inconvenient to use, particularly for transporting wheat, as goods were unloaded on one side and then reloaded on the other. For Tooleybuc a bridge would provide a convenient, permanent crossing place which would:

Serve as a means of railway connection with the development and cultivation of Western Riverina taking Balranald as a centre. ...it is expected that these new highways will result in a greater quantity of produce being brought into Victoria for conveyance on the railways (RR, 4/1/1922)

Under an agreement between the two States, NSW would be responsible for the preparation of plans and the general supervision of construction work. In 1921 the design for a timber truss and beam span bridge with steel lift span was approved by the NSW Government and tenders were subsequently invited for the bridge construction. Those received were found to be:

So much in advance of the Departmental estimate [of £21000] that it has been decided to construct the work by day labour, and tenders for the supply of ironwork have been invited (DPW, 1920-21: 4)

The lowest tender for the manufacture and supply of metal work for the new structure was received from the NSW Government Dockyard, Newcastle for £5697 and the rest of the work was to be carried out by day labourers. As it was to be constructed at the same time as bridges at Carrathool over the Murrumbidgee and at Mulwala over the Murray River, a special officer was appointed to oversee construction; Mr Keating was awarded this role (DPW 1922: 38). Figure 5.78 shows the vertical lift towers of the bridge completed at Newcastle's Walsh Island Dockyard prior to disassembly for transfer to the bridge site.

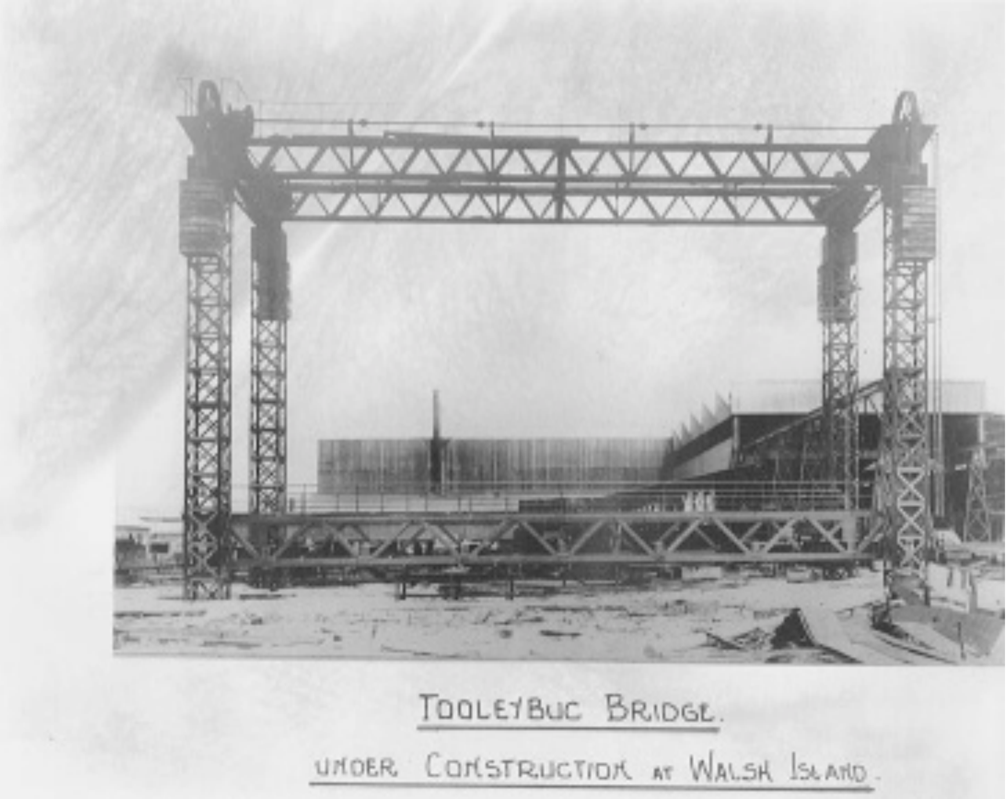


Figure 5.78 Tooleybuc Bridge lift tower under construction at Walsh Island Dockyard and Engineering Works, Newcastle (Source: Digital Hunter 03600079)

Government engineers visited Tooleybuc in early January 1922 to organise materials and labour, hoping that the work could proceed quickly as the River was then at a low level. Local feeling was that the Bridge would be completed in time to allow next year's harvest to move freely across the River thus offering:

... a great saving to all the farmers, also owners of sheep and cattle going to the fat stock markets. (RR, 11/1/1922)

By May of that year the Engineer in charge of works, Mr. Keating, was at Tooleybuc and preliminary work had already started. Raw materials were shipped to Piangil Railway Station on the Victorian side of the River and carted to the Bridge site. It was expected that 20 to 30 men would be employed on the project (*RR,* 31/5/1922*).* Several photographs were taken of the Bridge during construction, one of which shows a number of workmen engaged in building the timber sections of the Bridge (Figure 5.79 and Figure 5.80). Local optimism was high and it was thought that the Bridge would help with moves to have the railway line extended to Balranald in NSW, and thus improve the prospects for Tooleybuc's economic growth.

Figure 5.79 Lift towers assembly (Source: Swan Hill Regional Library)

Figure 5.80 Tooleybuc Bridge during construction 1924 (Source: Hickey 1992)

Work on the Bridge did not proceed as expected and over a year later, much later than the next harvest, a deputation was sent to the Minister for Public Works urging that the Bridge be completed in time for the following harvest. The response was positive and it was noted that all efforts would be made to push the work ahead, with the Bridge engineer promising that the concrete work would be finished within three months (*RR,* 4/7/1923).

In March of the following year when the concrete for the cylinders was being put down, a serious accident occurred again delaying the works. The Engineer in charge, Mr Keating climbed on to a platform erected for the purpose of inspecting the procedure.

Unfortunately he lost his balance and fell over twenty feet. He sustained serious injuries to his head and upper body, and died without regaining consciousness. A funeral was held the following day which was described as being the largest ever seen in Tooleybuc, showing the respect with which Mr. Keating was held by locals (*RR,* 5/3/1924).

Following this the construction of the Tooleybuc Bridge was finished without further incident. Tickets were offered for sale to attend the official opening, scheduled for December 1924. However, the ceremony was delayed due to many of the parliamentary party being unable to attend. In February 1925 an announcement was made that the opening was to go ahead on the 20th of February with the NSW Minister for Public Works officiating. A large turnout was anticipated to witness “another link in binding Victoria to the Mother State” (*RR,* 7/2/1925).

The opening was in fact well attended with representatives of both State Governments and also the local shires of Wakool and Swan Hill. The Bridge designer, Mr. Percy Allan was present and after the Bridge was opened, and the lift span raised, he was seen on top of the span apparently inspecting the workings. Lifting the span took nine minutes.

In his address the Victorian Minister for Public Works saw the Bridge and associated road and rail networks as having broken down the barriers between the two States making them ‘Australian’ (*RR,* 28/2/1925)..

The final cost of the Bridge was £28,795 (DPW 1924-5:30-1). It was proclaimed a National work on 3rd August, 1928 (RTA file 469.1316). The Bridge has been an important factor in the development of Tooleybuc, and it is still considered a popular crossing point for tourist and freight traffic travelling between Sydney and Adelaide. It also was an important factor in choosing the town as the site for a new central district school in 1953 (Hickey 1992: 35).

Operational history

As a lift span bridge, a caretaker was appointed to Tooleybuc Bridge to open the Bridge for river traffic and to perform general maintenance and cleaning duties. This position was tendered for in 1925 and granted to Mr. S. Mensforth. Land for a caretaker’s cottage was resumed in 1924 located close to the Bridge which was now occupied by Mr. Mensforth and family. As part of his duties the caretaker was required to open the Bridge “at any hour of the day or night” at the request of the Master of a vessel and to so in a regulation manner to avoid delays (RTA 469.1344, Pt 1).

The position was held by Mr Mensforth until the 1940s when he enrolled for military service and his wife took over the duties. The contract passed back to Mr. Mensforth in 1948, still at the same annual rate negotiated over 25 years previously. Upon his retirement in 1957 his son was granted the position, at a rate of £80 per year, but lost it in 1960 when a considerably lower quote was received. Files show that a caretaker was still in the employ of the Department up until 1994 and that bridge openings had become less frequent, operating mostly for tourist traffic (RTA Bridge File 469.1344, Pt 2). The caretaker's cottage (Figure 5.81) remains on site and is now managed by Wakool Council; all lifting operations on the bridge have been undertaken by council officers since 1994. The lift span remains in regular but infrequent use.

Lift operations at Tooleybuc Bridge were not always without incident as was highlighted during a lift in 1974; the paddle steamer *Pevensey*, which is one of the largest cargo and towing steam paddlers on the Murray River, collided with the bridge after passing through the open bridge heading upstream. The steamer attempted to move to the south bank after clearing the bridge, but was caught in the strong current and swept sideways into the east side of the bridge. The bridge sustained no noticeable damage, but the *Pevensey* suffered some damage to her upper works (Swan Hill Historical Society).

Figure 5.81 The Bridge caretaker's cottage built in 1925 is located on the Victorian bank and remains a prominent building within Tooleybuc

Maintenance history

In 1938 a proclamation issued by the NSW Government declared the Bridge, previously maintained and managed by the NSW Department of Public Works to now become the responsibility of the Commissioner for Main Roads (*GG,* 25/3/1938).

As with many other timber bridges continual maintenance requirements and high costs have often been a factor in requests for replacement bridges. In 1969 letters from concerned locals were sent to the local M.L.A. One described the Tooleybuc Bridge as ‘ancient’ and further went on to say that:

There is also the inconvenience to travellers and the likelihood that one of these narrow, rustic bridges will be the cause of a fatality

A reply from the Main Roads Department noted that the issue would also need to be considered by the Victorian Country Roads Board. It was unlikely that the matter could be carried out in the immediate future as there were many other bridge projects of greater urgency which would have to take precedence (RTA 469.1316, Pt. 2).

RTA files provide an account of the repairs and maintenance carried out on the Bridge. The following table is a summary of the major repair work carried out on Tooleybuc Bridge from available records. All information the consultant had access to have been used to generate this table, however it is not possible to provide greater detail due to the level of operational recording previously carried out.

Table 5-15 Tooleybuc Bridge – Summary of maintenance history

Date	Description
1925-39	Minor maintenance only
1962	Additional counterweights added to lift span
1973	Steel inspection recommends repairs to corroded tower bases, steel trusses, rebalance and lubricate lift span.
1974-75	Steelwork repainted, lifting mechanism cleaned, lubricated; additional flitches renewed
1982	Scour protection work at Pier 2; steel sheeting and concrete reinforcement
1982-86	Lift span deck strengthened through the replacement of 12 timber stringers with steel I-girders.
1999	Work recommended: strengthen truss lower chord, replace timber cross and sway girders with steel ones, check lift span (completed in late 1999).
2001	Lift span towers strengthened through welding additional plate sections to the top chords.

5.7.2 Statement of significance

Tooleybuc Bridge is assessed as being of State Significance, primarily on the basis of its technical and historical significance. It is a representative example of all Allan timber truss road bridges. The vertical lift span is a rare feature, and has associational links with the historic river trade, and has much to reveal about late 19th century civil engineering and manufacturing technology. The Tooleybuc Bridge is the last of the timber truss bridges with lift span built over the Murray River and reflects a pivotal point in NSW's history where the importance of navigable rivers as trade routes is failing. Allan trusses were third in a five-stage design evolution of NSW timber truss bridges, and were a major improvement over the McDonald truss, which preceded them. Allan trusses were 20 per cent cheaper to build than McDonald trusses, could carry 50 per cent more load, and were easier to maintain. Completed in 1925, the Tooleybuc Bridge is an Allan type timber truss road bridge, and has an Allan type vertical lift span to allow river craft to pass. As a timber truss road bridge, it has many associational links with important historical events, trends and people, including the expansion of the road network and economic activity throughout NSW, and Percy Allan, the designer of this type of truss.

Source: RMS s170 Register

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Not listed
OEH Heritage Division State Heritage Register	Listed
Victorian Heritage Register	Listed
Wakool Shire Council Local Environmental Plan, 2013	Not listed
NSW National Trust Register	Listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications and summary of heritage assessments

There were no modifications apparent between the opening structure of the Tooleybuc Bridge and its predecessor Swan Hill. There were changes to the supporting piers, with the design being one of the first to adopted reinforced concrete piers in lieu of cast iron piers with concrete infill.

Table 5-16 Tooleybuc Bridge – Summary of modifications

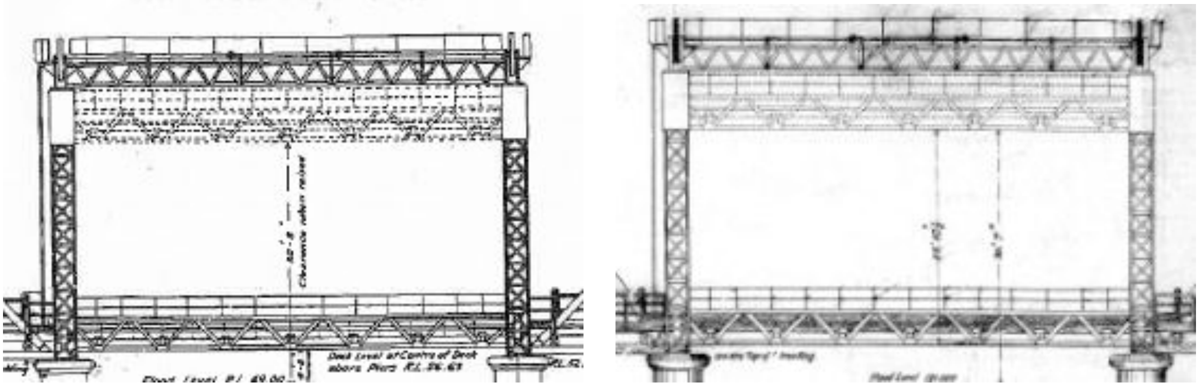
Preceding Designs	Issues with Design	Evolution at Tooleybuc
Cast and wrought iron piers with concrete infill	-	Reinforced Concrete piers with reinforced concrete diaphragm.

5.7.3 Description of lift span mechanism components

Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance.

The design of the Tooleybuc Bridge is similar to that adopted for the Swan Hill Bridge. When comparing elevations of the two bridges, it is apparent that no major changes were implemented. As there are a limited number of drawings available for Tooleybuc, the descriptions contained within this report are visually portrayed using drawings of Swan Hill as it is evident that the designs are almost identical (Figure 5.82).



Tooleybuc Elevation

Swan Hill Elevation

Figure 5.82 Comparison of Swan Hill and Tooleybuc Elevations

The towers of the bridge consist of a wrought iron lattice type structure with square top section of wrought iron plating (Figure 5.83). Following on from preceding designs, the tops of the towers were restrained diagonally braced longitudinal girders, transverse diagonal cross braced girders and wind bracing (Figure 5.84).

The alignment of the longitudinal girders has been offset from the towers by approximately 4 ft. to allow for the supporting arrangement for the transverse sheaves. It also provides support to the longitudinal shaft connecting the sheaves at the top of each tower.

Figure 5.83 Towers and counterweights on Tooleybuc Bridge

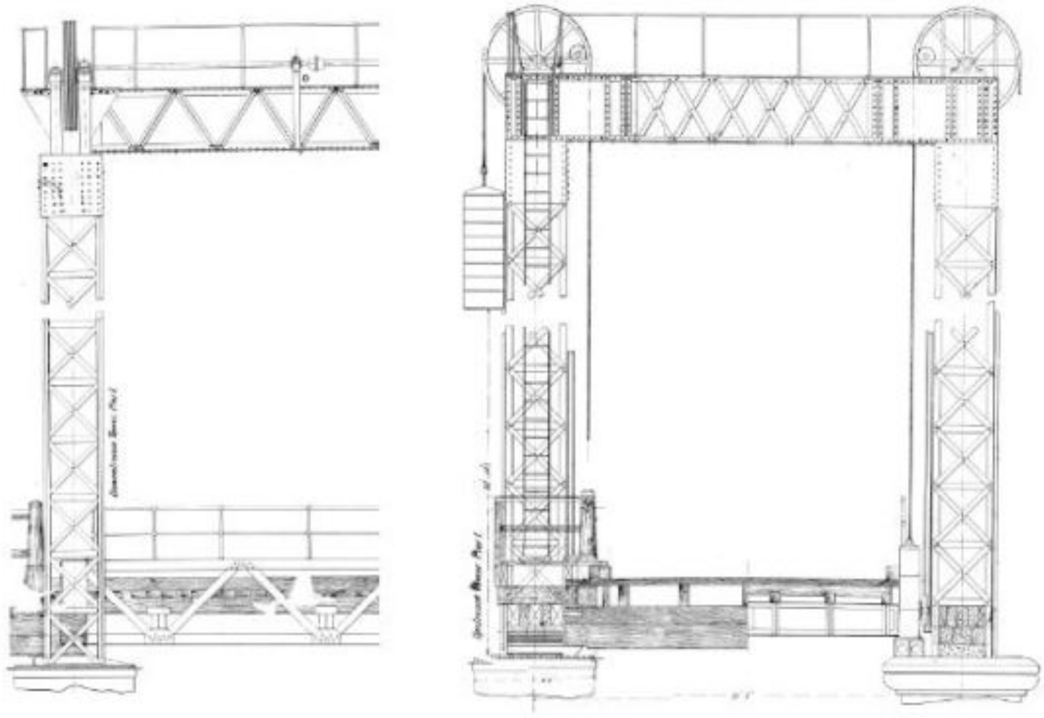


Figure 5.84 Drawing of lattice towers, transverse and longitudinal girders on Swan Hill Bridge

Movable span

The form and fabric of the movable span is of MODERATE significance.

The movable span consists of two main longitudinal wrought iron Warren type trusses that support the steel plate web cross girders (Figure 5.85). The cross girders vary between being straight at the terminal end and fish-bellied for the intermediate girders. The stringers are of sawn timber construct that finally supports the timber decking (Figure 5.86).

Figure 5.85 Detailed view of movable span of Tooleybuc Bridge (Source: RMS)

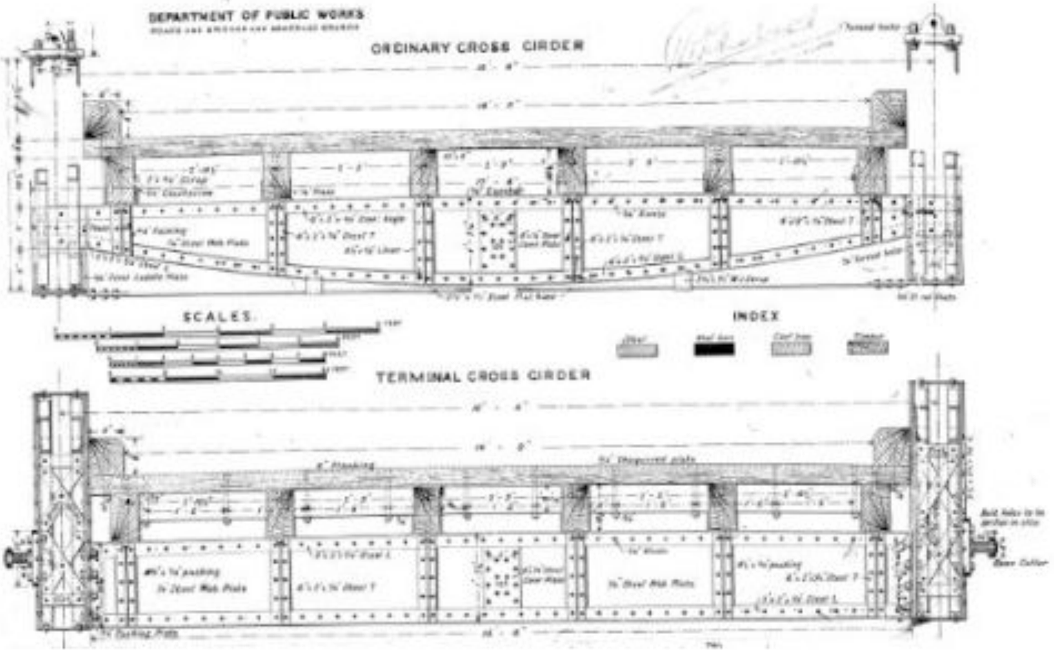


Figure 5.86 Cross sections of the Swan Hill Bridge lift span

Connection between the lift span and the wire ropes is achieved by way of ferrules and clamps around a pin supported in a suspension bracket at each corner (Figure 5.87). The lift span also has inner guide wheels with an allowance for bearing on a bull-headed rail bolted down the side of the tower.

Figure 5.87 Lifting span attach point (Source: RMS)

Counterweight

The form and fabric of the counterweight is of MODERATE significance.

The balance weights of the system were hung on the sides of the lifting towers and were cast iron with adjustable lead ingot filling (Figure 5.88). The gutter balance box typically weighed around 34¼ tons though there was an allowance for adjustments in case of any weight fluctuations due to water on the road or future modifications to the lift span. The balance weights were guided by steel angles bolted in a v-shape to the two edges of the lattice tower facing the weights.

As with the Swan Hill Bridge design, the arrangement of having the counter balance weights on the outside of the tower had two advantages. The first was a reduction in friction compared to positioning the weights inside the tower. The second advantage was that this arrangement allowed for the sheaves to be mounted on the centre line of the towers thus eliminating eccentric loads.

Figure 5.88 Tooleybuc Bridge Counterweights (Source: RMS)

Sheaves and winch mechanism

The form and fabric of the sheaves is of MODERATE significance.

The sheaves consist of a cast iron wheel which is mounted at the top of each tower. The have four grooves set in to contain the wire ropes during operation.

Mechanical components

The form and fabric of the mechanical components is of MODERATE significance.

The driving control of the bridge was provided by a combination of shafts and wire ropes. The winch at deck level turns a vertical shaft reaching up to the top of the tower. The direction of rotation is then transferred by a pinion and gear into the first longitudinal shaft that connects onto the mitred rim of the sheave causing rotation, thus lowering the balance weight and lifting the span that is joined by the wire ropes (Figure 5.89). The uniform transfer of driving force to all sheaves is provided by the linking of two longitudinal shafts by a transverse shaft. This arrangement also allows for single person operation of the lift span.

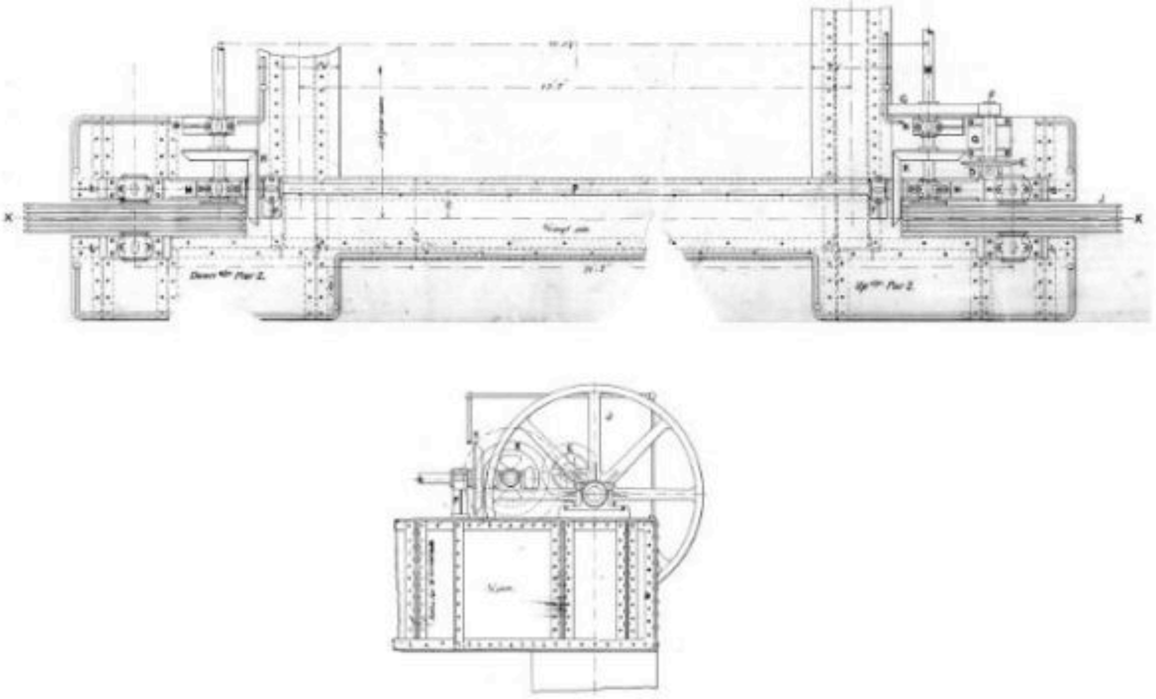


Figure 5.89 **Plans of the similar design that was adopted at Swan Hill Bridge**

Vehicle and pedestrian barrier

Figure 5.90 **Pedestrian barrier attached to timber railing when not in use**

The form and fabric of the vehicle and pedestrian barriers are of LOW significance.

Metal gate are positioned at the beginning of each truss approach span.

Ropes

The form and fabric of the ropes is of LOW significance.

The wire ropes that were implemented at Tooleybuc were composed of six strands around a core of hemp. Each strand contained seven mild crucible steel wires with the final design having a factor of safety of approximately 7.75 during the lift.

The force required to lift the span was a combination of the wire rope self-weight, resistance due to bending over the sheaves and overall friction in the system. The rope self-weight was taken as 430 lb and the combined bending resistance and friction as 1370 lb. Hence the required load to overcome was 1800 lb. This was met by allowing for an effective power of one man to be 18 lb and a gearing ratio of 34:1. The total time taken for one operator to lift the span is approximately 10 ¼ minutes.

Motors and electrical

NO significance.

Motors and electrical components were never installed on Tooleybuc Bridge. It remained manually operated throughout the initial period of its operation. Since 1997 a hydraulic motor has been used to drive the opening mechanism of the bridge. Wakool Council employees bring the portable device to site in order to raise the bridge (Figure 5.91).

Figure 5.91 Portable motor fitted to Tooleybuc Bridge to raise the span

Summary of heritage assessments

The significances of each bridge component are summarised in the table below.

Table 5-17 Tooleybuc Bridge – Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL
Movable Span	MODERATE
Counterweights	MODERATE
Sheaves and winch drums	MODERATE
Mechanical components	MODERATE
Vehicle and pedestrian barriers	LOW
Ropes	LOW
Motors and electrical	NO

5.8 GONN CROSSING BRIDGE

(Robinvale Type, built 1926)

5.8.1 Description of the Bridge

The design of the bridge over the Murray River at Gonn Crossing is similar to that adopted for Robinvale Bridge completed in 1925. The Bridge consists of a steel vertical lifting span with length 60 ft., two steel plate girder spans with lengths 90 ft. each and four approach spans each 24 ft. in length.

The upper framework of the lifting span generally consists of four steel plate columns that are restrained at the top by both transverse and longitudinal Warren type steel girders. The lift span itself is a steel plate web girder with transverse stiffeners and the entire superstructure is supported on reinforced concrete piers.

Figure 5.92 General View of Gonn Crossing Bridge (Source: GHD)

Development of roads and transportation in the Gonn Crossing region

The area surrounding the Gonn Crossing Bridge was originally a large pastoral station owned by Robert Beauchamp in 1850. The property was named Gonn and by the 1860s approximately 4000 sheep were run on the station. Due to the presence of a convenient crossing location on the Murray River a punt was provided resulting in the development of a small town consisting of a boarding house, post-office and a black smith. This town ship was known as Gonn Crossing and it was heavily reliant on the Murray River trade.

The settlement later rallied for a rail-link to be extended to the town from the newly constructed lines to Kerang and Swan Hill. Eventually the Victorian Railways agreed to build the line stretching north to the Gonn Crossing area and it was the second of four bridges to be built across the Murray as part of the Border Railways Agreement.

Design and construction

The bridge was designed in Victoria with the purpose of carrying both rail and road traffic and subsequently the bridge is wider than all preceding vertical lift bridges, with a width of 18 ft. compared to the typical 14 ft. (see Figure 5.93). It was formally opened by the Mr Eggleston, Minister for Railways assisted by Mr Angus M.L.A. on 1st July 1926. The bridge was on the railway line from Kerang to Stony Crossing, 16½ miles from Kerang, 1½ miles from Murrabit and 39 miles from Stony Crossing. Mr Angus was reported as stating "in the next 10 years, when the Hume Reservoir is completed, the land between Wakool and the Murray would become the garden of the Riverina" (*Argus*, 2 July, 1926: 13).

Figure 5.93 Train on Gonn Crossing Bridge 1926 (Source: State Library of Victoria, mp013888)

The estimated cost of The Bridge was £49,000, though it was finally completed at a cost of £59,791. The increase was attributed to the extra cost of laying a permanent way for the railway, an increase in wages and other items not allowed for in the estimate (PWD 1927).

As the bridge site was located a considerable distance from Gonn Crossing the new township of Murrabit was surveyed in 1922 to form the north side of the bridge and to the end of the railway. Allotments were sold in 1924. A hall and Anglican church were built in 1926. The Gonn Crossing Bridge acts as the gateway between Kerang and Murrabit. As the two towns are not large there is considerable commuting across the bridge for services that are not duplicated in each town. In 1961 the railway was closed and the Bridge has remained open to road traffic only.

Operational History

As with other later movable span bridges (post 1900), the Gonn Crossing Bridge lift span was used relatively infrequently as river trade, by the period of its construction, was on the decline (Fraser, 2005). Test lifts have been made at regular intervals but accurate records of operational lifts have never been kept.

From the 1990s after more than ten years of drought and a low Murray River, river traffic was at a minimum and the high clearance under the bridge resulted in only 1 lift request from river boats or paddle steamers in 2006. The lift span remains in regular but infrequent use. Figure 5.94 shows the completed bridge with a streamer passing below the raised span.

Figure 5.94 Steamers passing under Gonn Crossing Bridge in 2000 (Source: State Library of Victoria)

Using the winch lifting device one man can lift the span in about five minutes.

Maintenance History

Access arrangements on the bridge have been modified since construction to better meet worker health and safety requirements as required.

5.8.2 Statement of significance

Gonn Crossing Bridge is of Local significance. The location has historical and social significance as the catalyst for development of Murrabit. The bridge is a unique type of Murray River Crossing due to the unusual design, and particularly the unusual lift span.

Source: RMS s170 Register

Heritage Listings

Listing	Status
Australian Heritage Database (formerly the Register of the National Estate)	Not listed
OEH Heritage Division State Heritage Register	Not listed
Victorian Heritage Register	Not listed
Wakool Shire Council Local Environmental Plan, 2013	Not listed
NSW National Trust Register	Not listed
RTA s.170 Heritage and Conservation Register	Listed

Evolution of modifications

In summary, the modifications of the Gonn Crossing design consist of the implementation of steel plate towers and a new Warren type truss wind cross brace. The base of the tower is connected to the concrete piers by base plates and hold down bolts. Finally, the lifting mechanism was by improved implementing an extra rope at each corner into the design and utilising a new counter weight design.

Table 5-18 Gonn Crossing Bridge – Summary of modifications

Preceding Designs	Issues with Design	Evolution at Gonn Crossing
Lattice Towers	Expensive for fabrication and assembly	Steel plate tower
Rod wind brace arrangement	-	Warren type truss wind bracing
Tower set 6 ft. into concrete	-	Base plates and hold down bolts implemented for design.
Only two ropes used for lifting mechanism	Inadequate redundancy	Three ropes adopted in design.
Four individual counterweights	Expensive utilisation of lead and iron due to size limitations, also require greater number of connections	Two weights extended across width of road giving larger volume therefore concrete can be implemented for infill

5.8.3 Description of lift span mechanism components

Lift Span Towers

The form and fabric of the lift span towers is of EXCEPTIONAL significance.

The design of the Gonn Crossing Bridge was a second generation vertical lift bridge.

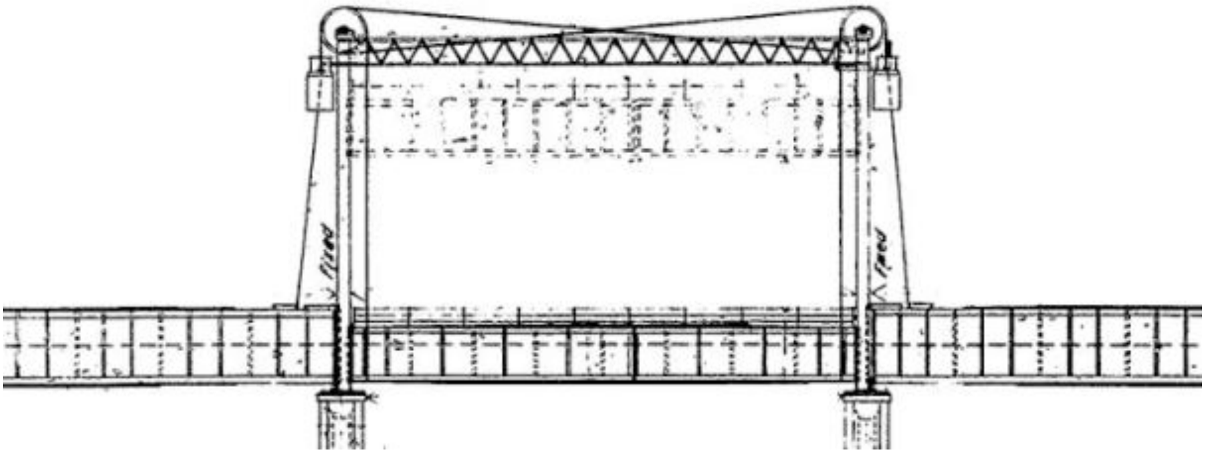


Figure 5.95 Elevation of Gonn Crossing Bridge

The towers of the bridge consist of a mild steel plate construct with concrete infill (Figure 5.95). This is the first time that this arrangement was adopted and it is a further evolution of previous lattice tower designs. Top restraint is provided by steel Warren type transverse and longitudinal girders (Figure 5.96) and the wind bracing is also a new design as it is achieved by Warren type trusses opposed to tie rods.

The longitudinal girders are aligned with the towers and the piers supporting the towers are made entirely of reinforced concrete. The bottom end fixing of the tower is achieved by base plates and this is advanced of previous base connections that would simply set the base of the tower at least 6 ft. into the concrete infill of the piers.

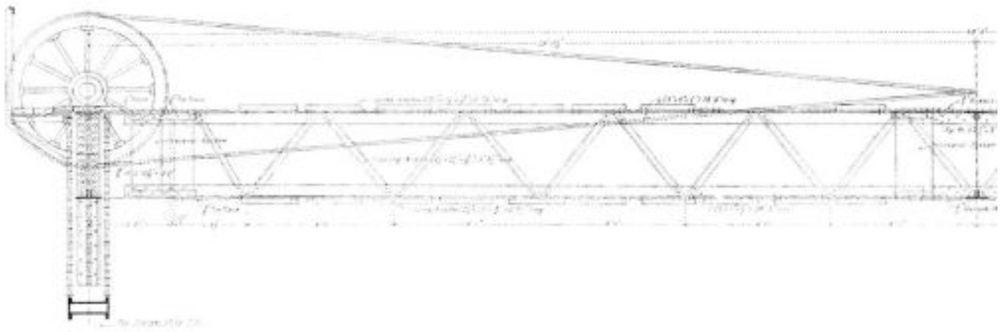


Figure 5.96 Elevation of Gonn Crossing sheave and tower brace arrangement

Movable span

The form and fabric of the movable span is of HIGH significance.

The lift design adopts a mild steel plate web girder with transverse stiffeners. These girders support steel plate web cross girders and steel stringers that finally supported the timber decking and rail line. The deck was later substantially modified to remove the rails and allow for only road and pedestrian passage (Figure 5.97).

Figure 5.97 Bridge deck and Compensating bracket (Source: GHD)

The connection between the wire ropes and the lift span is achieved by the same design as Barham Bridge, namely by implementing stretching screws (Figure 5.97). This allows for small adjustments of the connection length. The stretching screw is then attached to the ropes by shackles. The preceding wire rope arrangement was further improved by the implementation of a third wire rope into the design, thus introducing redundancy into the system. It should also be noted that a subsequent compensating bracket was designed that incorporated a new connection for all three wire ropes.

Counterweights

The form and fabric of the movable span is of HIGH significance.

The counter weights of the system appear to be a significant evolution form previous Australian designs. Previous designs have implemented four individual counter weights that were placed on each tower of the bridge. The Gonn Crossing design only has two counter weights that have been extended across the width of the bridge being supported by wire ropes at each end. The concrete weights are hung on the opposite side of the tower to the lift span and an interesting guide wheel arrangement is implemented, whereby the weights run along the flange of each tower thus restricting lateral movement.

As with the Barham Bridge design, the arrangement of having the balance weights on the opposite side of the tower has the advantage that the sheaves can be mounted on the centre line of the towers thus eliminating eccentric loads.

Counterweights have been modified through the addition of a light weight steel cage to prevent concrete from falling onto the deck.

Figure 5.98 Gonn Crossing counterweights (Source: RMS)

Sheaves and winch mechanism

The form and fabric of the sheave and winch mechanism components is of EXCEPTIONAL significance.

The sheaves adopted on Gonn Crossing Bridge consist of cast iron rims with wrought iron spokes. There are orientated longitudinally and a moulded with grooves to house the two counterweight ropes and one haul rope.

Figure 5.99 Sheave on Gonn Crossing (Source: GHD)

The winch mechanism originally consisted of a handle and number of gears that were mounted on the top of a tower. The winch mechanism is shown in Figure 5.100.

Figure 5.100 Winch and sheave mechanism for Gonn Crossing (Source: RMS)

Mechanical components

The form and fabric of the mechanical components is of EXCEPTIONAL significance.

The lifting mechanism is based on the previous E. M. De Burgh design of Barham-Koondrook without any noticeable improvements. The driving control is provided by a combination of wire ropes and shafts. The winch mechanism is located at the top of the tower and it turns gears that subsequently transfer rotation to the first transverse shaft. The rotation of this shaft causes the rotation of the sheaves, lowering of the balance weights and subsequent lifting of the span (Figure 5.100).

The uniform transfer of driving force to all sheaves is provided by the implementation of transverse shafts and wire ropes in the longitudinal direction. Starting from the lifting span, wire ropes pass around the sheave and cross longitudinally along the vertical span. After which the ropes pass over the sheave at the opposite end of the span and attach to the counter weights. The rope arrangement as described above only relates to one of the wire ropes connected to each corner of the lift span. The remaining two ropes at each corner simply travel from the lift span up and over the sheave and directly down onto the counter weight.

Vehicle and pedestrian barriers

The form and fabric of the vehicle and pedestrian barriers component is of LOW significance.

The vehicle and pedestrian barriers have been modified from the original design and have been relocated from the road approaches to the sit either side of the movable span (Figure 5.101).

Figure 5.101 Gate on Gonn Crossing Bridge (Source: RMS)

Ropes

The form and fabric of the rope components is of LOW significance.

The original wire ropes consisted of wire strands wound around a hemp core.

Figure 5.102 Wire ropes on Gonn Crossing Bridge

Motors and electrical

The form and fabric of the motors and electrical components is of LOW significance.

Hydraulic Motors were installed on winch mechanism with hydraulic lines run down to deck level where a portable hydraulic power pack drives the motor. Since 1997 Wakool Council employees utilise a portable power pack on site to raise the bridge.

Summary of heritage assessments

The significances of each bridge component are summarised in the table below.

Table 5-19 Gonn Crossing Bridge – Summary of heritage significance

Bridge Component	Significance Grading
Towers	EXCEPTIONAL
Movable Span	HIGH
Counterweights	EXCEPTIONAL
Sheaves and winch mechanism	EXCEPTIONAL
Mechanical components	EXCEPTIONAL
Vehicle and pedestrian barriers	LOW
Ropes	LOW
Motors and electrical	LOW