THE GUNDAGAI HISTORIC BRIDGES

OVER THE MURRUMBIDGEE RIVER AND FLOOD PLAIN

NOMINATION AS

HISTORIC ENGINEERING MARKERS

Top *the 1867 Prince Alfred Bridge* and below *the 1903 railway truss.*

Prepared for
The Engineering Heritage Committee, Sydney Division, I E Aust
by Donald J Fraser, July 1998

CONTENTS

STATEMENTS OF SIGNIFICANCE

The historic bridges at Gundagai consist of

an iron-truss road bridge named the Prince Alfred Bridge, 1867
a timber beam road viaduct, 1869, reconstructed 1898
a timber truss railway viaduct, 1903
a steel pin-jointed railway truss, 1903.

Each and collectively they have high heritage significance because the history of Gundagai is the history of a river town plagued by floods and where its bridges, particularly the Prince Alfred Bridge and its approach viaduct, were essential to maintaining land communication.

THE PRINCE ALFRED BRIDGE

- the iron-truss road bridge is the second-oldest existing metal truss bridge in Australia, the oldest in New South Wales.
- it is an integral part of one of the longest road bridges in Australia, certainly in New South Wales.
- the bridge has the unique feature of the trusses being suspended from a continuous horizontal top member which is supported on roller roller bearings on vertical steel posts at each pier.
- it is a British pin-jointed truss which demonstrates that pin-jointed construction did not originate in the USA even though it was more widely used there from the 1880s.
- it and the railway truss downstream are two of the three pin-jointed trusses in New South Wales that are either in use or still in their original place - the third is the Whipple truss road bridge at Nowra, and there are replaced railway Whipple trusses on display at Lewisham, Sydney.
- it was one of the earliest major bridge works of the fledgeling Department of Public Works.
- it represented a political message from the Sydney-based governments to the Riverina district that improvements to roads, that were important to them, were being seriously addressed and that there was no need to secede to Victoria.
- it has high social significance due to it carrying local and Hume Highway traffic for 131 years.

THE RAILWAY TRUSS

- it is the only surviving railway pin-jointed truss in New South Wales.
- it is an excellent example of a typical American hog-backed, steel, pin-jointed truss.
- with its companion bridge upstream, the Prince Alfred Bridge, and the road truss bridge at Nowra, they comprise the only three surviving pin-jointed trusses in New South Wales.
- it is one of a small group of contemporary steel trusses, road and rail, that survive to mark the change to American bridge technology in New South Wales at the turn of the century.
- it is an integral part of one of the longest railway river crossings in New South Wales.

THE TIMBER VIADUCTS

- the railway timber truss viaduct is the longest of its type in Australia.
- the road timber girder viaduct is among the longest of its type in Australia, and is the longest in New South Wales.
- these viaducts are important visual elements in the Gundagai landscape.
- the road viaducts have had strong social significance due to them carrying local and Hume Highway traffic for 108 years.
- the axis view of the now disused road viaduct emphasises length and the distance required to cross the wide flood plain of the Murrumbidgee River.
- viewing the railway truss viaduct from the flat ground, there is a strong sense of grandeur and engineering geometry.
- like the railway truss over the river, the timber trusses are of American original, being Howe trusses, and so represent the change from British or European styles of timber trusses to American technology.
- the trusses are deck trusses and there are only four other railway sites in New South Wales with timber deck trusses - there are three other sites with through trusses.

NOMINATION FORMS

There are 2 forms for each of the 4 historic bridges, on the next 8 pages.

PLAQUE CITATIONS

It is proposed to request 2 plaques, one for the road bridges and the other for the railway bridges. Draft wordings follow the nomination forms.

Commemorative Plaque Nomination Form

Date ....July 1998

To:
Commemorative Plaque Sub-Committee
The Institution of Engineers, Australia
Engineering House
11 National Circuit
BARTON ACT 2600

From

Engineering
Heritage Committee
Sydney Division, I E Aust

Nominating Body

The following work is nominated for a :-

- ~~National Engineering Landmark~~
- Historic Engineering Marker
  (delete as appropriate)

Name of work ....Prince Alfred Bridge, Gundagai, NSW

Location ....Over Murrumbidgee River at South Gundagai

....

Owner .... Roads and Traffic Authority, NSW (RTA)

....

Owner's response ....RTA supports the nomination

....

Access to site ....Open access, bridge still in use

Future care and maintenance of the work .....Ongoing by RTA

....

Name of sponsor ....Nil

For a NEL, is an information plaque required ? ....Nil

Ken Wyatt...
Chairperson of nominating committee

Ken Wyatt...
Chairperson of Division Heritage Committee

ADDITIONAL SUPPORTING INFORMATION

Name of work ....Prince Alfred Bridge, Gundagai, NSW

Year of construction or manufacture 1867

Period of operation ....131 years and still in service

Physical condition ....Good

Engineering Heritage Significance :-

Technological, scientific value ....Sophisiticated structural engineering for its time

Historical value ....Second oldest existing metal truss bridge in Australia

Social value ....Functional bridge for 131 years, highly esteemed by local community

Landscape or township value ....Important component of the river landscape

Rarity...Only bridge of its type in Australia

Representativeness ....Only one of its type

Contribution to nation or region ....Carried Hume Highway traffic for 110 years

Contribution to engineering ....A major work of colonial engineering

Persons associated with the work ....Francis Bell (Contractor), Fitzroy Iron Works, PWD

Integrity..Its original fabric is intact

Authenticity...It is the original structure

Comparable works (a) in Australia ....None

(b) overseas ....Hungerford Rly Bridge, River Thames, London

Statement of significance, its location in the supporting documentation

....See table of contents

Citation (70 words is optimum) ....See table of contents

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Attachments to submission (if any) ....Copies of technical papers by Don Freser

....

Proposed location of plaque (if not at site)....Possibly on a cairn where both viaducts meet

Commemorative Plaque Nomination Form

Date ....July 1998

To:
Commemorative Plaque Sub-Committee
The Institution of Engineers, Australia
Engineering House
11 National Circuit
BARTON ACT 2600

From

Engineering
Heritage Committee
Sydney Division, I E Aust

Nominating Body

The following work is nominated for a :-

- ~~National Engineering Landmark~~
- Historic Engineering Marker
  (delete as appropriate)

Name of work ....Timber viaduct approach to the Prince Alfred Bridge, Gundagai

Location..Flood plain of the Murrumbidgee River, Gundagai

....

Owner..Gundagai Historic Bridges Inc

....

Owner's response ....They support the nomination

....

Access to site...Viaduct closed to traffic but pedestrains can cross

Future care and maintenance of the work ....Gundagai Historic Bridges Inc

....

Name of sponsor...Nil

For a NEL, is an information plaque required ? ...Nil

Ken Wyatt..
Chairperson of nominating committee

Ken Wyatt..
Chairperson of Division Heritage Committee

ADDITIONAL SUPPORTING INFORMATION

Name of work ....Timber viaduct approach to Prince Alfred Bridge, Gundagai

Year of construction or manufacture ....1869, reconstructed 1898

Period of operation .... 1869 - 1977

Physical condition ....Fair to poor

Engineering Heritage Significance :-

Technological, scientific value ....A standard timber girder structure

Historical value .....Both viaducts provided the **HISTORICAL LINK** to Prince Alfred Bridge

Social value ......Functional viaducts for 108 years, well known to drivers as the "rattley" bridge

Landscape or township value .... A dominant feature of the flood plain landscape

Rarity.......................................Not rare in terms of type of construction but is very long, 800 m

Representativeness ....Standard timber girder construction but unique in length

Contribution to nation or region ....Present viaduct carried Hume Highway traffic for 90 years

Contribution to engineering ....Major works of colonial engineering

Persons associated with the work ....Department of Public Works, W. Pickering (Contractor)

Integrity ....In general appearance, the fabric is colonial but most timbers have been replaced

Authenticity ....The style of construction is original but each span is propped at mid-span

Comparable works (a) in Australia ....There are other long timber road viaducts

(b) overseas ....Not researched but there would be many

Statement of significance, its location in the supporting documentation

....See table of contents

Citation (70 words is optimum) ....See table of contents

Attachments to submission (if any) ....Copies of technical papers by Don Fraser

Proposed location of plaque (if not at site).............Possibly on a cairn where viaducts meet

Commemorative Plaque Nomination Form

Date ....July 1998

To:
Commemorative Plaque Sub-Committee
The Institution of Engineers, Australia
Engineering House
11 National Circuit
BARTON ACT 2600

From

Engineering
Heritage Committee
Sydney Division, I E Aust

Nominating Body

The following work is nominated for a :-

- ~~National Engineering Landmark~~
- Historic Engineering Marker
  (delete as appropriate)

Name of work ....Railway steel truss bridge

Location...................................Over Murrumbidgee River, Gundagai, NSW

....

Owner.......................................Rail Access Corporation, State Rail Authority NSW

....

Owner's response ....Supports the nomination provided that "it will in no way limit

......................................any future action the RAC may consider necessary for the bridge"

Access to site ....Deck level is closed to public access but bridge is viewable from river banks

Future care and maintenance of the work ....Rail Access Corporation

....

Name of sponsor ....Nil

For a NEL, is an information plaque required ? ....Nil

Ken Wyatt..
Chairperson of nominating committee

Ken Wyatt..
Chairperson of Division Heritage Committee

ADDITIONAL SUPPORTING INFORMATION

Name of work ....Railway steel truss bridge, Gundagai, NSW

Year of construction or manufacture 1903

Period of operation ....1903 - 1985

Physical condition .... Good

Engineering Heritage Significance :-

Technological, scientific value ....Typical American pin-jointed truss, rare in Australia

Historical value ....Part of change from British to American bridge technology begun in 1892

Social value ....Helped develop the country through to Tumut

Landscape or township value ....Important component of the river landscape

Rarity..Last NSW railway truss of its type in its original place

Representativeness ....Last survivor of 3 pin-jointed railway truss bridges

Contribution to nation or region ....Served the Tumut district for 82 years

Contribution to engineering ....An experimental bridge that proved merits of rivets

Persons associated with the work ....A & P Roberts, USA (maker), Engineers of Railway Construction Branch, Deprartment of Public Works

Integrity..The bridge has its original fabric

Authenticity..It is the original bridge

Comparable works (a) in Australia ....One of a few surviving pin-jointed trusses

(b) overseas ....Plenty in North America

Statement of significance, its location in the supporting documentation

....See table of contents

Citation (70 words is optimum) ....See table of contents

Attachments to submission (if any) ....Copies of technical papers by Don Fraser

Proposed location of plaque (if not at site).......Possibly on a cairn where the viaducts meet

Commemorative Plaque Nomination Form

Date..............July 1998

To:
Commemorative Plaque Sub-Committee
The Institution of Engineers, Australia
Engineering House
11 National Circuit
BARTON ACT 2600

From

Engineering
Heritage Committee
Sydney Division, I E Aust

Nominating Body

The following work is nominated for a :-

- ~~National Engineering Landmark~~
- Historic Engineering Marker
  (delete as appropriate)

Name of work ....Railway timber truss viaduct.

Location..................................Flood plain of the Murrumbidgee River, Gundagai, NSW

....

Owner......................................Rail Access Corporation, State Rail Authority NSW

....

Owner's response ....Supports the nomination provided that "it will in no way limit

.....................................any future action the RAC may consider necessary for the bridge"

Access to site ....Deck level is closed to public access but viaduct is viewable from river flats

Future care and maintenance of the work ....Rail Access Corporation

....

Name of sponsor...Nil

For a NEL, is an information plaque required ? ....Nil

.Ken Wyatt.......................................
Chairperson of nominating committee

Ken Wyatt...
Chairperson of Division Heritage Committee

ADDITIONAL SUPPORTING INFORMATION

Name of work ....Railway timber truss viaduct, Gundagai, NSW

Year of construction or manufacture 1903

Period of operation ....1903 - 1985

Physical condition .... Good to fair

Engineering Heritage Significance :-

Technological, scientific value ....Timber Howe trusses of the deck type

Historical value ....Part of change from British to American bridge technology begun in 1892

Social value...Helped develop the country through to Tumut

Landscape or township value ....A dominant feature of the flood plain landscape

Rarity..Longest timber truss viaduct in Australia

Representativeness ....Good example of use of timber for low-cost railways

Contribution to nation or region ....Served the Tumut district for 82 years

Contribution to engineering ....Demonstrated the viability of timber for major bridges

Persons associated with the work ....Engineers of the Railway Construction Branch, Deprartment of Public Works

Integrity..The viaduct has its original fabric

Authenticity...It is the original viaduct

Comparable works (a) in Australia ....There are some of these timber trusses

(b) overseas ....Plenty as covered bridges in North America

Statement of significance, its location in the supporting documentation

....See table of contents

Citation (70 words is optimum) ....See table of contents

Attachments to submission (if any) ....Copies of technical papers by Don Fraser

Proposed location of plaque (if not at site).......Possibly on a cairn where the viaducts meet

GUNDAGAI HISTORIC BRIDGES

DRAFTS OF WORDINGS FOR 2 PLAQUES

PLAQUE No 1

HISTORIC ENGINEERING MARKER

HISTORIC ROAD BRIDGES GUNDAGAI

THESE BRIDGES COMPRISE AN 1867 IRON PIN-JOINTED 3-SPAN WARREN TRUSS, THE SECOND OLDEST EXTANT IN AUSTRALIA, AND ITS RECONSTRUCTED TIMBER GIRDER VIADUCT, ONE OF THE LONGEST IN AUSTRALIA. BOTH CARRIED THE HUME HIGHWAY ACROSS THE MURRUMBIDGEE RIVER AND ITS FLOOD PLAIN FOR 110 YEARS. IN THE 1860s THE IRON TRUSS BRIDGE WAS A MAJOR ACHIEVEMENT, IT IS TECHNICALLY SOPHISTICATED AND IS STILL IN USE. THESE WORKS INVOLVED FRANCIS BELL, W. PICKERING AND ENGINEERS OF THE DEPARTMENT OF PUBLIC WORKS.
(79 Words)

THE INSTITUTION OF ENGINEERS, AUSTRALIA AND
GUNDAGAI HISTORIC BRIDGES INC, 1998

PLAQUE No 2

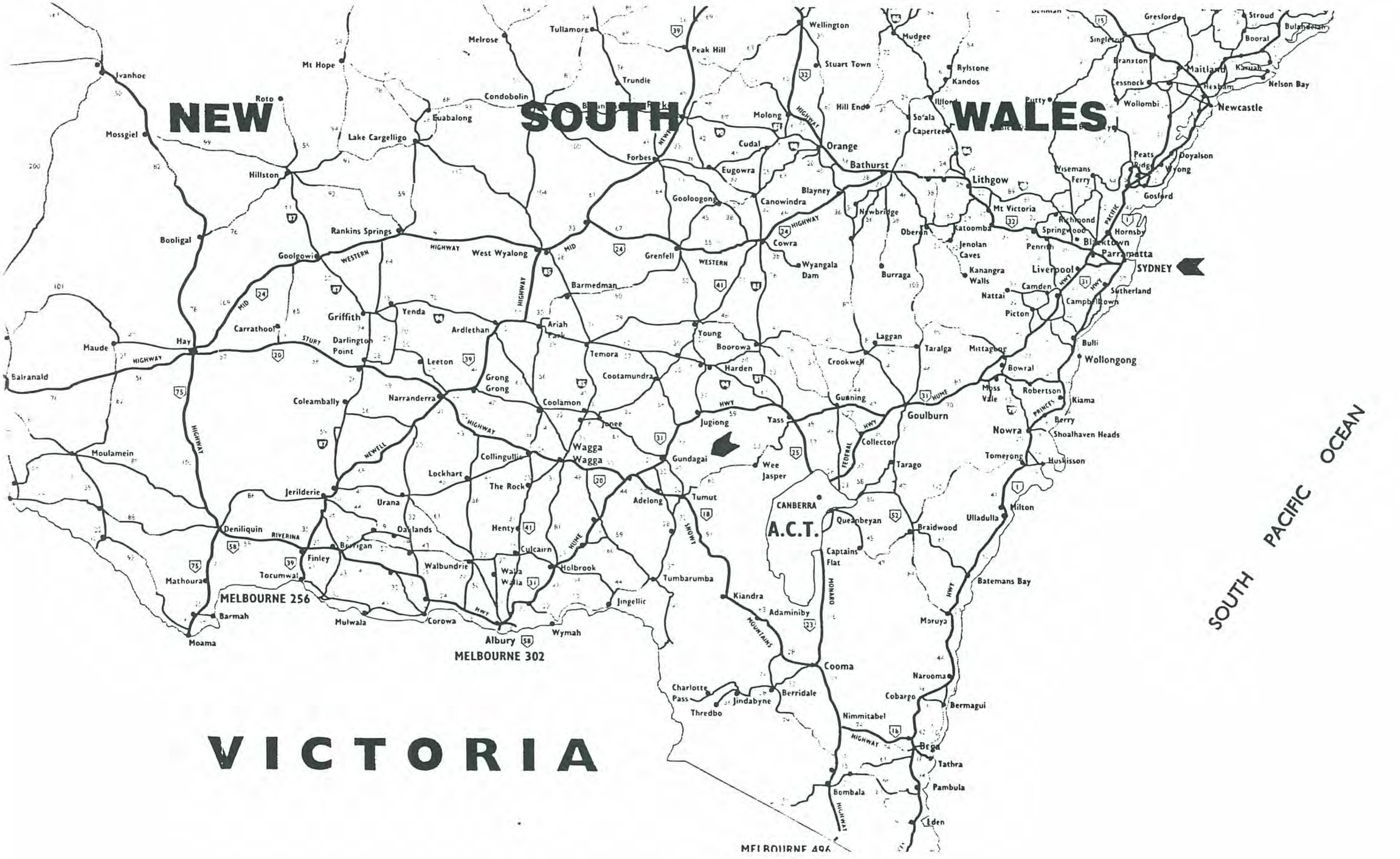
HISTORIC ENGINEERING MARKER

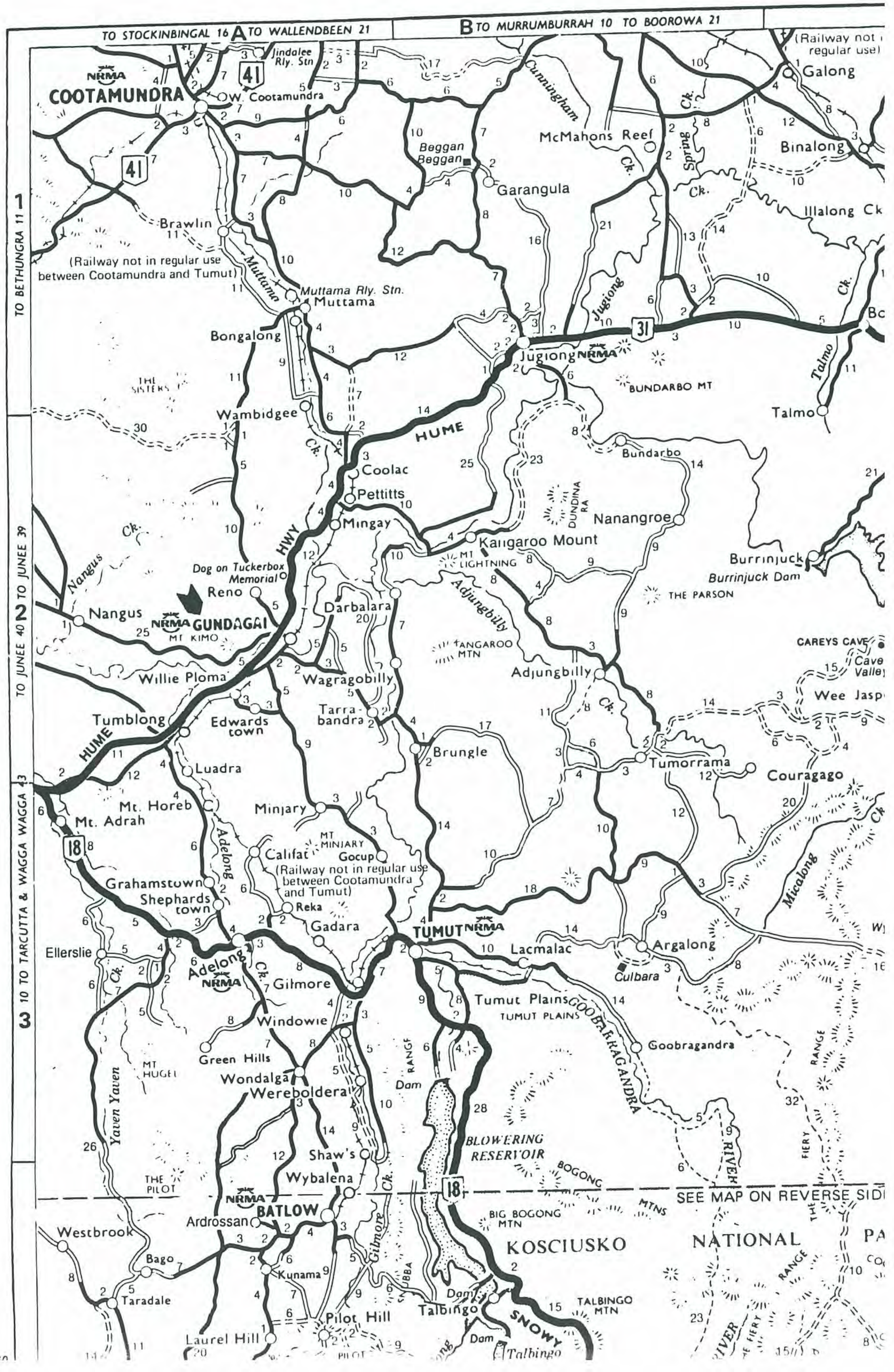
HISTORIC RAILWAY BRIDGES GUNDAGAI

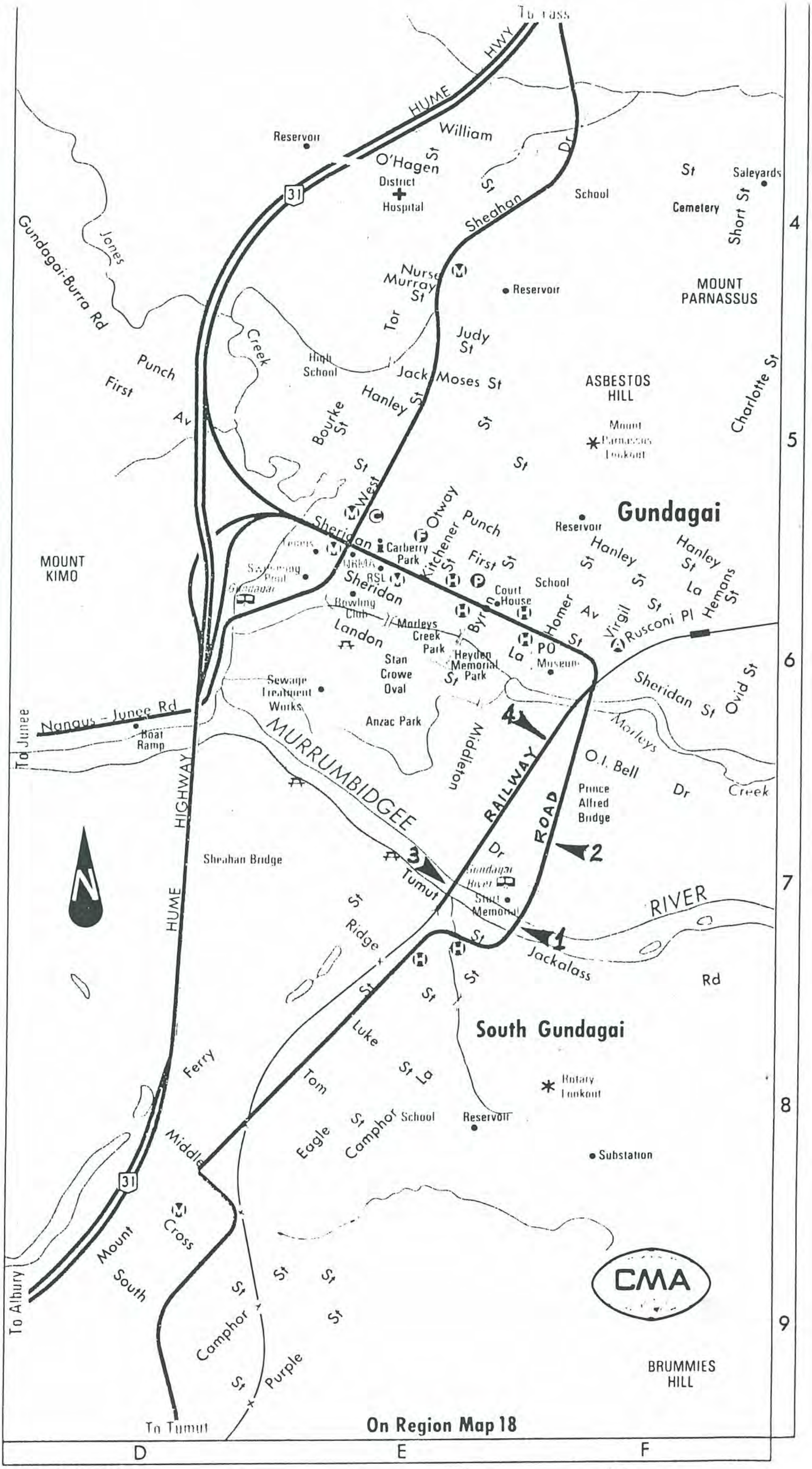
THESE 1903 BRIDGES COMPRISE A TYPICALLY AMERICAN STEEL PIN-JOINTED PRATT TRUSS MADE BY A & P ROBERTS, USA, OF 61 METRES SPAN AND ONE OF THE LARGEST IN NSW, PLUS A TIMBER HOWE TRUSS VIADUCT, THE LONGEST IN AUSTRALIA. BOTH CARRIED THE BRANCH RAILWAY TO TUMUT ACROSS THE MURRUMBIDGEE RIVER AND ITS FLOOD PLAIN FOR 82 YEARS. UNIQUELY,THE RIVER BRIDGES, ROAD AND RAIL, ARE PIN-JOINTED. THESE WORKS WERE ERECTED BY DAY LABOUR AND SUPERVISED BY ENGINEERS OF THE DEPARTMENT OF PUBLIC WORKS.

(83 Words)

THE INSTITUTION OF ENGINEERS, AUSTRALIA AND GUNDAGAI HISTORIC BRIDGES INC, 1998


NEW SOUTH WALES
VICTORIA
A.C.T.
SOUTH PACIFIC OCEAN
SYDNEY
CANBERRA
MELBOURNE 256
MELBOURNE 302
Wellington
Peak Hill
Tullamore
Melrose
Mt Hope
Ivanhoe
Roto
Mossgiel
Condobolin
Euabalong
Lake Cargelligo
Hillston
Booligal
Rankins Springs
Goolgowi
West Wyalong
Griffith
Yenda
Carrathool
Hay
Maude
Balranald
Moulamein
Deniliquin
Mathoura
Moama
Barmah
Tocumwal
Finley
Berrigan
Jerilderie
Urana
Oaklands
Mulwala
Corowa
Albury
Wymah
Walbundrie
Culcairn
Holbrook
Henty
The Rock
Lockhart
Collingullie
Wagga Wagga
Junee
Coolamon
Narranderra
Leeton
Ardlethan
Grong Grong
Coleambally
Darlington Point
Temora
Ariah Park
Barmedman
Cootamundra
Young
Boorowa
Harden
Jugiong
Gundagai
Tumut
Adelong
Tumbarumba
Jingellic
Wee Jasper
Yass
Gunning
Goulburn
Collector
Tarago
Queanbeyan
Captains Flat
Braidwood
Cooma
Adaminaby
Kiandra
Berridale
Jindabyne
Charlotte Pass
Thredbo
Nimmitabel
Bombala
Bega
Tathra
Pambula
Eden
Cobargo
Bermagui
Narooma
Moruya
Batemans Bay
Ulladulla
Milton
Huskisson
Tomerong
Nowra
Shoalhaven Heads
Berry
Kiama
Robertson
Moss Vale
Bowral
Mittagong
Wollongong
Bulli
Picton
Camden
Campbelltown
Sutherland
Liverpool
Parramatta
Blacktown
Hornsby
Penrith
Springwood
Richmond
Katoomba
Mt Victoria
Lithgow
Jenolan Caves
Kanangra Walls
Nattai
Oberon
Burraga
Taralga
Laggan
Crookwell
Bathurst
Orange
Blayney
Newbridge
Canowindra
Cowra
Wyangala Dam
Eugowra
Cudal
Molong
Gooloogong
Grenfell
Forbes
Trundie
Stuart Town
Hill End
Sofala
Capertee
Rylstone
Kandos
Mudgee
Ilford
Wisemans Ferry
Wollombi
Cessnock
Branxton
Singleton
Gresford
Maitland
Hexham
Newcastle
Nelson Bay
Karuah
Booral
Stroud
Bulahdelah
Doyalson
Wyong
Gosford
Peats Ridge
Putty
PACIFIC
PRINCES
HUME
HWY
HIGHWAY
MID
WESTERN
NEWELL
STURT
RIVERINA
SNOWY
MOUNTAINS
MONARO
FEDERAL


TO STOCKINBINGAL 16 A TO WALLENDBEEN 21
B TO MURRUMBURRAH 10 TO BOOROWA 21
(Railway not in regular use)
TO BETHUNGRA 11
TO JUNEE 40 TO JUNEE 39
10 TO TARCUTTA & WAGGA WAGGA 43
COOTAMUNDRA
W. Cootamundra
Jindalee Rly. Stn
Brawlin
(Railway not in regular use between Cootamundra and Tumut)
Muttama
Muttama Rly. Stn.
Bongalong
THE SISTERS
Wambidgee
Beggan Beggan
Garangula
McMahons Reef
Cunningham
Galong
Binalong
Illalong Ck
Spring Ck.
Jugiong
Bundarbo
BUNDARBO MT
Talmo
Coolac
Pettitts
Mingay
HUME HWY
Dog on Tuckerbox Memorial
Reno
Nangus
GUNDAGAI
MT KIMO
Willie Ploma
Tumblong
Edwards town
Luadra
Mt. Horeb
Mt. Adrah
Darbalara
Wagragobilly
Tarrabandra
Brungle
Kangaroo Mount
MT LIGHTNING
DUNDINA RA
Nanangroe
Burrinjuck
Burrinjuck Dam
THE PARSON
Adjungbilly
KANGAROO MTN
CAREYS CAVE
Cave Valley
Wee Jasper
Tumorrama
Couragago
Minjary
MT MINJARY
Gocup
Califat
(Railway not in regular use between Cootamundra and Tumut)
Reka
Gadara
Grahamstown
Shephards town
Adelong
Ellerslie
Gilmore
TUMUT
Lacmalac
Argalong
Culbara
Tumut Plains
TUMUT PLAINS
GOOBARRAGANDRA
Goobragandra
Micalong
Windowie
Green Hills
MT HUGEL
Wondalga
Wereboldera
Yaven Yaven
Shaw's
Wybalena
THE PILOT
BLOWERING RESERVOIR
BOGONG
BIG BOGONG MTN
MTNS
SEE MAP ON REVERSE SIDE
BATLOW
Ardrossan
Westbrook
Bago
Taradale
Kunama
Pilot Hill
Laurel Hill
KOSCIUSKO NATIONAL PARK
Talbingo
TALBINGO MTN
SNOWY
FIERY RANGE
RIVER
Dam



k of space prevents street names from being shown on the map they are

HISTORIC GUNDAGAI

OVERVIEW

The origins of Gundagai stem from the famous trek by Hume and Hovell in 1824 from Sydney to Port Phillip (now Melbourne). Relative to the present site of the township, they appear to have crossed the Murrumbidgee River about 10 km north-east near the junction with the Tumut River.

Within a year the Stuckey brothers, Peter and Henry, from the Wollondilly River near Goulburn, established the "Willie Ploma" run, and in 1826 "Sugar" O'Brien established his run "Gundagai" which became the largest and best known in the district. The name is an abbreviation of an aboriginal word but the meaning has not been agreed upon.

In 1829 Capt. Charles Sturt was commissioned by Governor Darling to explore the Murrumbidgee River to its source. On 28th November his party used an existing ford to reach the southern bank on a stretch of the river flowing east to west. This was to become the site of the township of Gundagai. More settlers followed and the new runs of "Kimo", "Nangus", Muttama" and "Wantabadgery" were established in the district.

But it was another 9 years before settlers, other than squatter-graziers, arrived in large numbers. This followed (Sir) Thomas Mitchell's epic journey in 1836 when he travelled via Gundagai to the Murray River and continued across what was to become Victoria, to Portland. His glowing reports stimulated a great pastoral development down the south-west slopes and into the Riverina, and onto the Western Districts of Victoria. Consequently, the main route south crossed the Murrumbidgee River at Gundagai. The town was gazetted on 10th October 1838 and its layout was designed by the Deputy Surveyor-General, Capt. Perry.

Unfortunately, the town was sited on the flood plain on the northern side of the river, despite warnings by the aborigines that flooding was sure to occur, which it did in 1844. But damage was light and most settlers stayed in the town whereas a few moved to the high ground on the southern bank, later to become South Gundagai.

A ferry service across the river was gazetted on 7th September 1849 and remained in use until a permanent bridge over the river was completed in 1867. Tolls, relative to the colony's economy, were high; people at 3 pence each is equivalent to around $4 in 1998, and laden drays could be 10 times dearer. But the ferry was in heavy demand as the rural trade steadily increased and the movement of people to the southern goldfields reached stampede proportions in the 1850s.

The town on the flood plain grew rapidly and on the eve of the Great Flood of 1852 there were four hotels, a flour mill, stores, a blacksmith's shop, a school, a post office, a Court House and lock-up, and numerous houses.

On the days before 23rd June 1852 torrential rain fell on the Murrumbidgee catchment and the river rose rapidly such that a wave of water and mud was surging down its course. About midnight on that fateful day the flood hit Gundagai, sweeping away most of the original town; 83 inhabitants perished. By 1853 a new town site had been chosen on the high ground north of the flood plain and its main street, Sheridan Street, became part of the Great South Road, subsequently the original Hume Highway.

The new town grew rapidly due to a combination of local trade and commerce, the flow of normal traffic between New South Wales and Victoria using the 1867 bridge and 1869 viaduct, and the gold rushes between 1858 - 1875. There was also a brief contact with the River Trade when Capt. Cadell reached Gundagai in 1858 with his paddle steamer "Albury" but the greater risks navigating upstream of Narrandera soon ended the enterprise.

Gold and wealthy travellers attracted the attention of bushrangers with notorieties such as Gardiner, Peisley, Gilbert, Ben Hall and Capt. "Moonlight" all active in the area.

Settlement and prosperity were consolidated during 1875 - 1894 when agricultural and pastoral development boomed. A branch railway from Cootamundra (on the main Sydney - Melbourne line) was completed to Gundagai in 1886 and the town became a Municipality in 1889. A new local gold began in 1894 but petered out around 1900.

By 1903, plans to tap the rural wealth of the Tumut district were realised when the railway was extended across the river flats on a long timber truss viaduct then by a 61 metre (200 feet) American steel truss across the river channel, then 51 kms via Mount Horeb to Tumut. Like the 1886 arrival of the railway, the extension caused jubilation and much celebrations with the attendance of the Governor Sir Harry Rawson, Premier Sir John See and the Minister for Public Works E. W. O'Sulivan.

In 1925 Gundagai experienced one of its most destructive floods. The amount of water was such that upstream at the Burrenjuck Dam the water passed over the top of the dam wall by about 2 metres. Fortunately the effect of the Snowy Scheme has been to reduce the flood peak by nearly 2 metres and the dam has been raised and strengthened.

Gundagai became part of Australia's folk lore due to the popularity of the poem "Nile Miles from Gundagai" and its subsequent setting to music as "Along the road to Gundagai", plus the legendary "Snake Gulley" family of Dad, Dave, Mum and Mabel. On 28th November 1932 a Pioneers Monument, the famous Dog on the Tucker Box (as featured in the poem), was unveiled by Prime Minister Joe Lyons. The sculpture of the dog was modelled by Frank Rusconi whose famous Marble Masterpiece (20,948 pieces forming a cathedral-in-minature and taking 28 years to complete) is still on display.

Gundagai's position on the Hume Highway ensured that it became a regular stop-over for travellers and a tourist destination. Even after the highway was relocated west of the town in 1977, the historical buildings, the two viaduct-bridges and the railway precinct continue to attract visitors, as the attached tourist booklet illustrates.

The historical viaduct - bridges are dealt with in the next section, but before that there is a series of photographs of some historic buildings in the town. There are many others and a walking - tour brochure is available from the Information Centre.

Eight photographs of some historic buildings follow.

Top *the 1849 flour mill, the only building to survive the 1852 flood* and below *the Museum with its facade from the original Bank of NSW.*

Top *a Federation corner shop* and below *the 1879 Post Office*.

Top *the 1859 Court House* and below *the 1858 Family Hotel.*

Top *an 1877 bank building* and below *the 1920s theatre - cinema.*

THE BRIDGES

OVERVIEW

By 1854 a track, serving as the Main Southern Road, extended from Yass to Albury, crossing the Murrumbidgee River at Gundagai. In his 3rd Report on Internal Communications (1859), Capt. Martindale noted that the "inhabitants of Gundagai were inconvenienced by creeks along the flats and submergence when the Murrumbidgee floods". Then in his 4th Report (1860) he advised governments of the priorities for improving roads "in the first place, bridge the creeks and rivers which habitually stopped traffic in times of floods, and in the second place, improve the worst places along the roads".

This policy and the increasing importance of the Main Southern Road gave a bridge over the Murrumbidgee at Gundagai a high priority.

Further impetus came from the establishment of the Roads Branch in the Department of Public Works in 1861 and the agitation from settlers in the Riverina for the Sydney-based governments to pay them more attention or they would secede to Victoria.

The threat was taken seriously and among the public works projects completed during the following decade was a long timber viaduct across the flood plain and an iron truss bridge over the river. The latter was completed first and opened on 17th October 1867 and named the Prince Alfred Bridge. The viaduct was completed in 1869 then reconstructed thirty years later, thus maintaining the flood-free link from Gundagai to the Prince Alfred Bridge.

After 130 years of steadily increasing traffic densities and vehicle loads, the capacity of this combination was exceeded and so planning began in the 1970s for a new river crossing. Extensive investigations, including hydraulic modelling of the flood plain to study the effects of various levels of flooding, determined a site 1.6 kms downstream (west) of the existing structure where the river channel had moved across to the north and with the flood plain south. The new crossing consists of steel box girders over the river then a 24-span steel and concrete viaduct and was opened on 25th March 1977.

Thereafter, the old timber viaduct was closed and a road built on the flats linking mid-town Gundagai to the northern end of the 1867 iron truss bridge.

In between these two events, the railway extension from Gundagai to Tumut was completed in 1903. Its crossing of the Murrumbidgee involved a similar structural combination as for the road crossing; a long timber viaduct of truss rather than girder construction, then a single-span steel truss over the river rather than the three shorter spans for the road with piers in the river.

The old road crossing, 1867 iron truss bridge and its successive timber viaducts, and the 1903 railway crossing of steel truss and timber viaduct, are collectively known as the The Gundagai Historic Bridges and are the subject of this plaquing nomination.

These structures are dealt with in more detail in the following sections.

THE PRINCE ALFRED BRIDGE AND VIADUCT

On 30th January 1861 the *Sydney Morning Herald* reported that the Legislative Assembly had rejected a motion for a road bridge at Gundagai due to lack of funds and lack of evidence of need. So a public meeting was held in September at the Gundagai Court House which urged the construction of a bridge. The resolutions from the meeting together with a subsequent petition from the district were forwarded to Sydney for consideration by the Government. A decision was made to proceed with the project.

Initially, in late 1861, the Government placed £24,000 in the estimates for a modest scheme that had a short viaduct leaving the final section on the flat and subject to flooding. But in November 1864 the estimate was increased to £25,000 and an additional vote of £12,000 was such that "the total of £37,000 would admit of the whole of the river flat being bridged". The longer viaduct was indeed built as shown in the photograph of the reconstruction work.

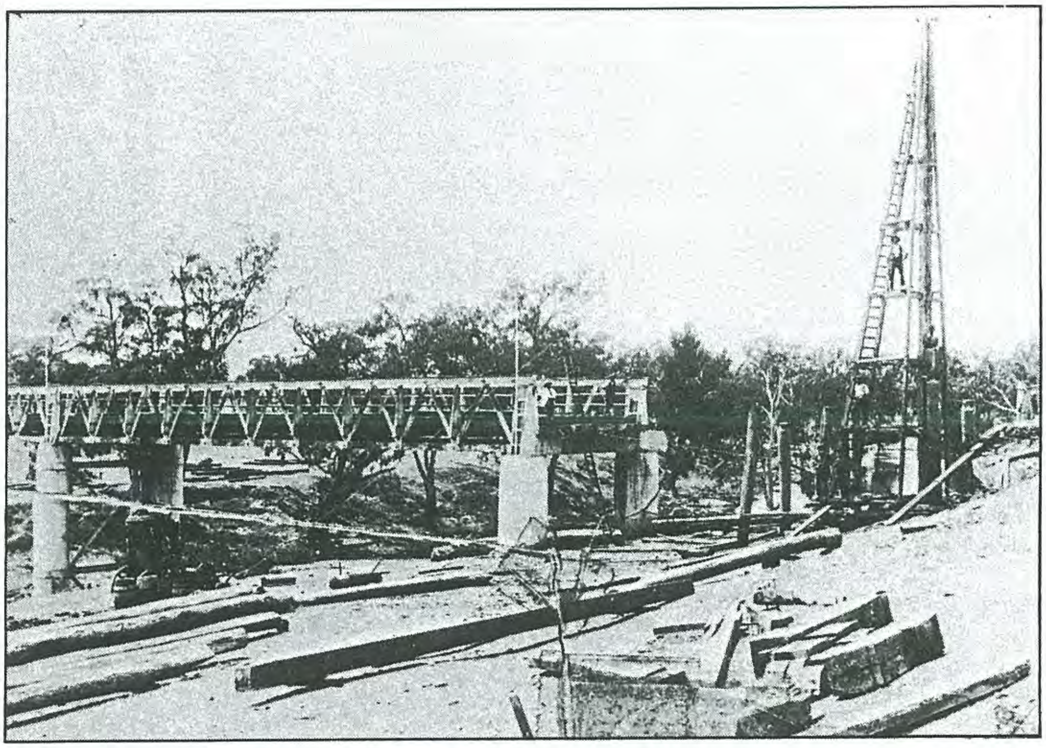
The scene in 1898 looking north as the reconstructed viaduct nears completion. The iron truss Prince Alfred Bridge is in the foreground and the 1869 viaduct is on the far right.

So, a bridge-viaduct combination 3087 feet long was built and completed in 1869 at a cost of around £38,000, equivalent to about $4 million today. The all-up cost of the steel and concrete 1977 Sheahan Bridge was near $6 million.

But returning to the structures of the late 1860s. The crossing consisted of a 3-span iron truss bridge over the main channel at South Gundagai with two short timber girder spans, and a 105-span timber girder viaduct across the flood plain to the eastern end of the town on the northern high ground.

From an engineering heritage point of view the 3-span iron truss bridge is the more important. It is the oldest surviving metal truss bridge in New South Wales and the second oldest in Australia. The 1870 Denison Bridge at Bathurst is the next and it was declared an Historic Engineering Marker in 1995. The Gundagai bridge was a remarkably sophisticated structure for the engineering staff of the fledgling Department of Public Works to undertake.

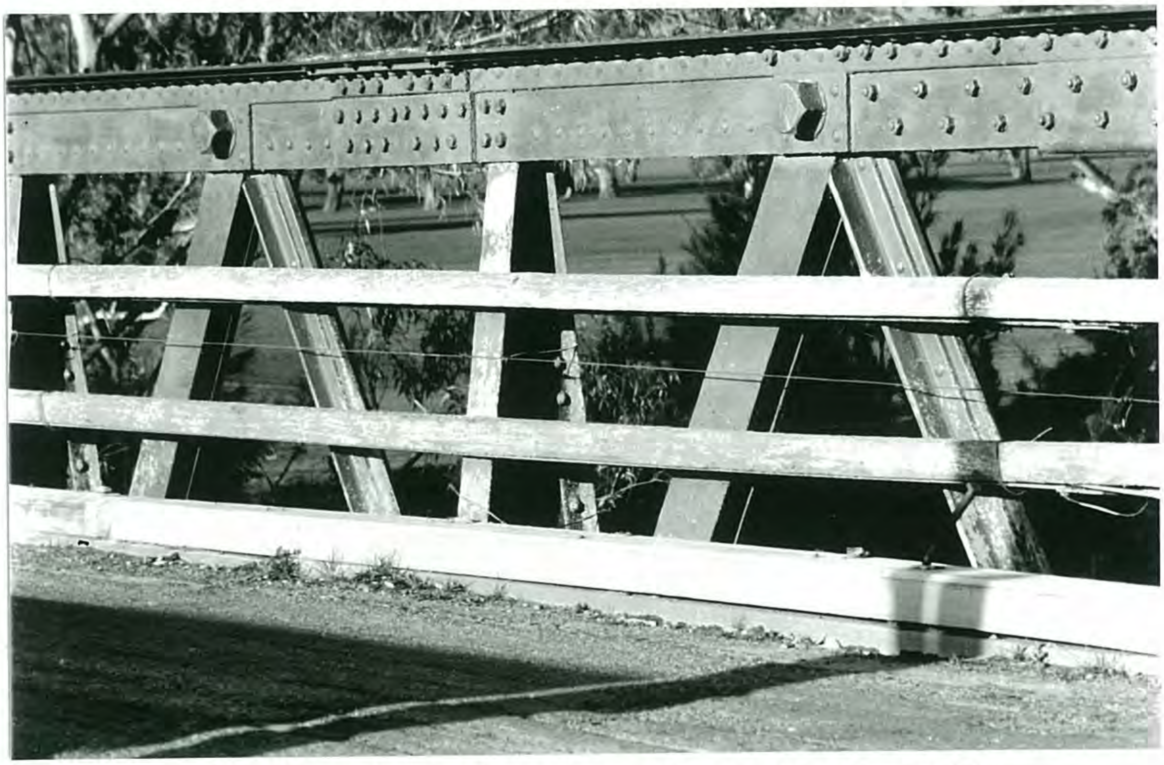
The four pairs of cast iron cylindrical piers were made at the Fitzroy Iron Works, Mittagong, in 56 sections each 6 feet long, 6 feet diameter, $1\frac{1}{8}$ inch wall thickness and weighing about 2 tons, and were delivered by bullock drays. They were assembled one on top of each other as internal excavation proceeded until founded on rock then filled with concrete.



The Prince Alfred Bridge during construction in 1866. Timber piles are being driven for the temporary staging so the third truss span can be assembled.

Although the cast iron pier sections were made by the Fitzroy Iron Works, confirmed in Road Commissioner Bennett's 1870 Report, the company was not equipped to make wrought iron or roll structural shapes, as are present in the 1867 Gundagai trusses. That type of ironwork was imported from England but fabricated by local companies such as P. N. Russell & Co. in Sydney then forwarded to the site. At that time rolling marks were not used so the exact origin of the iron is not known.

The three wrought iron truss spans are of the Warren type (a continuous W-pattern of sloping members) with regular vertical members to give support to the horizontal top member which is in compression. The trusses are essentially composed of pin-jointed members there being single large diameter bolts at each joint rather than a collection of smaller rivets.



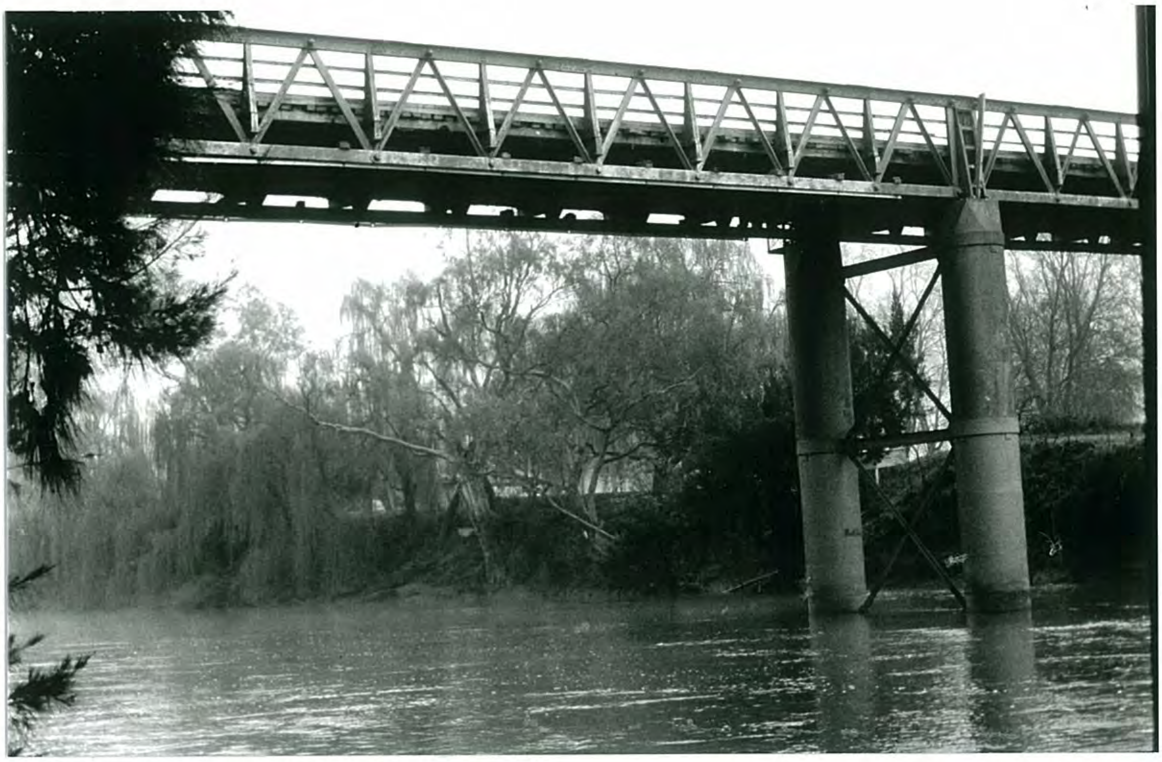
Deck level view showing the pin-jointed diagonal members and the vertical members propping the top member between panel points.

Conventionally, expansion bearings for bridge spans (be they simple sliding surfaces or rollers) are located at the bottom corners of each span. An unusual arrangement has been used on the Gundagai bridge. Strong vertical posts on each pier cylinder, extend almost to the underside of the top horizontal member which is continuous right across all three trusses and so over each pier. Where this member passes over the piers a set of roller bearings has been inserted. Therefore, the whole bridge is suspended at its two pairs of end posts and at the three intermediate pairs of posts at each pier, and so the bridge is completely free to move with the temperature variations. However, the posts prevent any accumulation of movement along the bridge, so it cannot slip off its bearings.

The unusual bearing arrangement on the Prince Alfred Bridge. Here at the end of the bridge, the cantilever stub of the top member sits on a linked set of 5 rollers which sit on the riveted vertical post which rests on the tops the piers, below. On the left is one of a vertical members of the truss which restricts the amount of movement of the rollers. A similar arrangement supports the continuous top member over the inner piers.

The successful tenderer for erecting the iron bridge over the river for £19,210 was Francis Bell who began the task in 1865. Erection of the superstructure, the trusses, was by the conventional method of assembling the iron members on temporary timber falsework supported by temporary piles in the river. Once the bridge was self- supporting the falsework was removed and the piles cut off below water.

The bridge was completed at a cost around £20,000 and was opened on 17th October 1867 amid great celebrations. Following a large procession Mrs E. G. Browne, wife of the Member for Tumut, formally named the bridge the Prince Alfred Bridge after Queen Victoria's second son and Duke of Edinburgh (Prince Albert, later King Edward VII, was in fact the Prince of Wales). The span near nearest South Gundagai was converted into a pavilion and at 5 o'clock 130 guests sat down to dinner and later toasted "Success to the bridge". Dancing and revelling continued at the hotels until next morning.



The completed Prince Alfred Bridge and commemorative plaque.

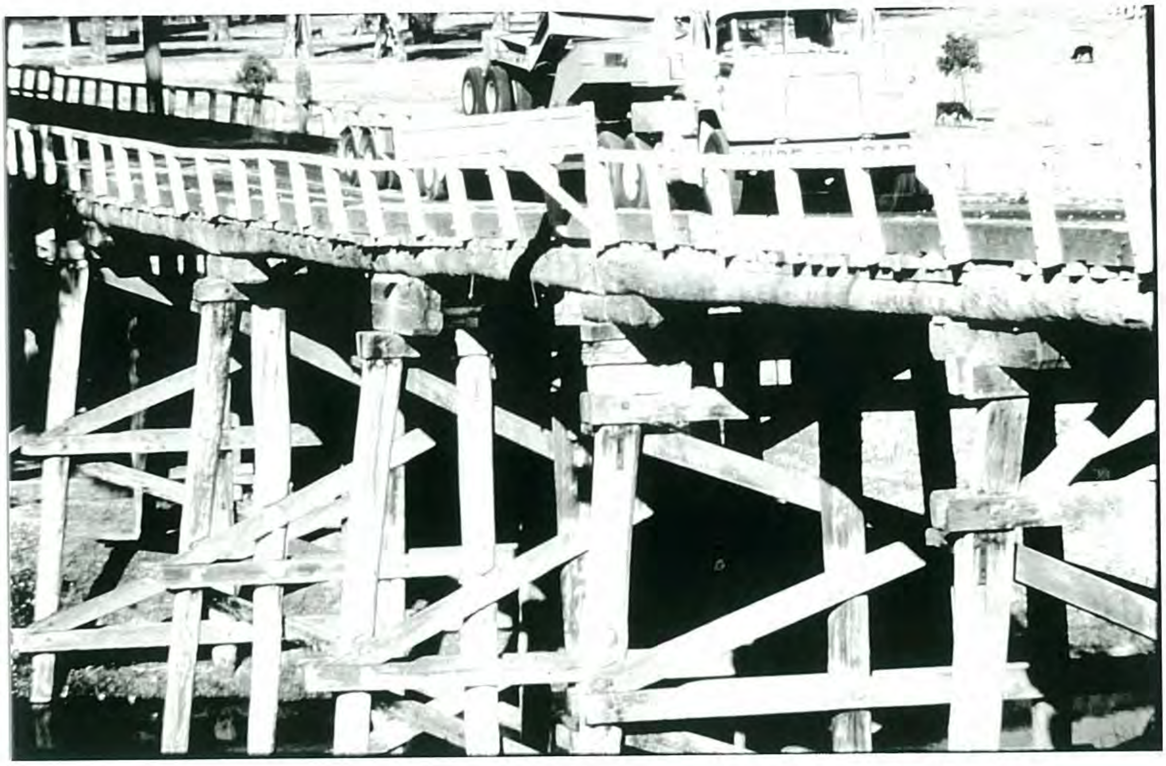
Note that the first long timber viaduct was not completed until 1869. A short sloping viaduct on a grade of 1 in 30 was used with the final 2000 feet of road made on the river flats. So the original 1861 scheme was actually built and used for about two years.

The viaduct was of conventional construction on timber trestles with a timber plank deck. Many thousands of such spans were built throughout the Colony, but not so many together forming such a long viaduct. It was built by Bailey, Rennie & Co. during 1866-1869 at a cost around £18,000. It became an important visual component of the crossing and was a feature of photographic reports in contemporary weekly newspapers of Gundagai and district.

By the 1890s the original viaduct was in poor condition and its deck level was dangerously close to the flood levels. The Department of Public Works decided to build a replacement viaduct with a higher deck to maintain the flood-free connection between the iron bridge and the town. A contract had been let to W. Pickering on 11th August 1896 for £12,591 and was completed a little over two years later in 1869 at £12,292. It required an enormous amount of timber, 21,690 lineal feet of piles and girders, 7,346 cubic feet of hewn timber for corbels and headstocks, and 430,000 super feet of sawn timber, mostly deck planks.

As traffic loads and densities increased, the strength of the viaduct became inadequate so every span was tommed at mid-span in the 1950s. When the 1977 steel and concrete crossing was completed, the viaduct was closed and listed for demolition but the iron-truss bridge was retained with an approach road on the river flood plain.

The viaduct was still, of course, a major visible element in the Gundagai landscape and it had a strong historical link to the colonial period. It was the one thing that travellers remembered - the long rattling rough ride on the viaduct, despite the technical excellence of the iron bridge.

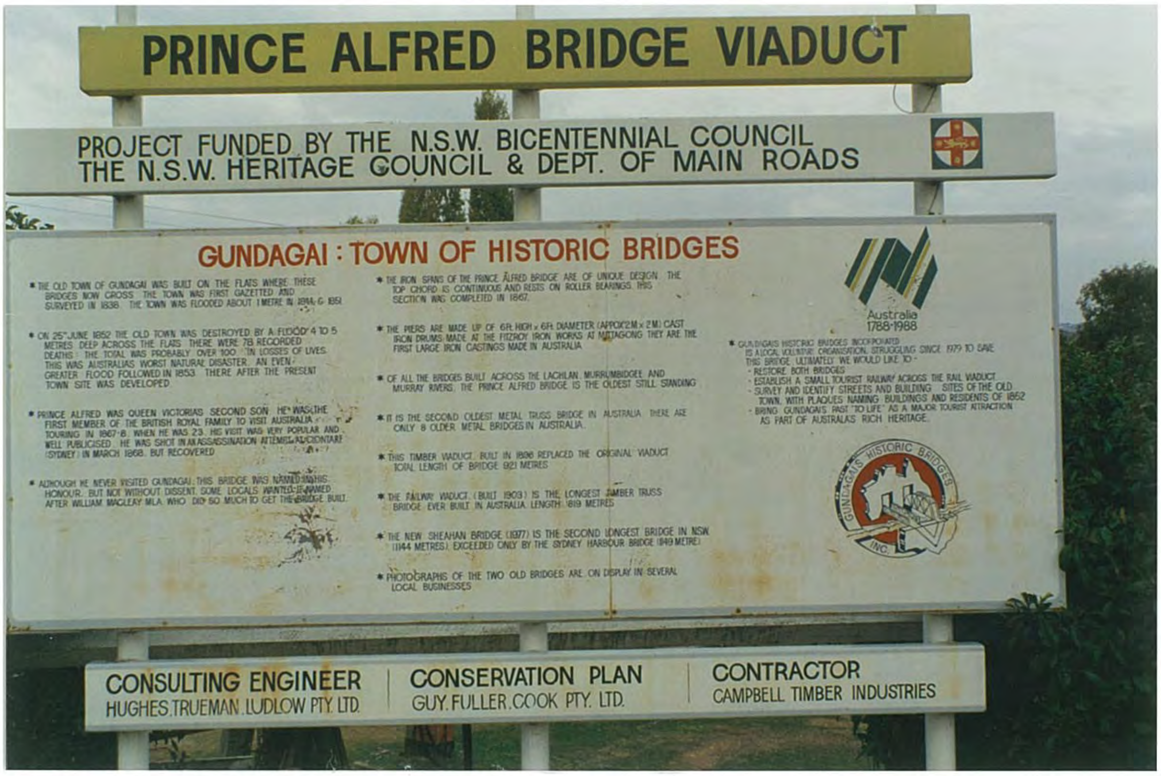


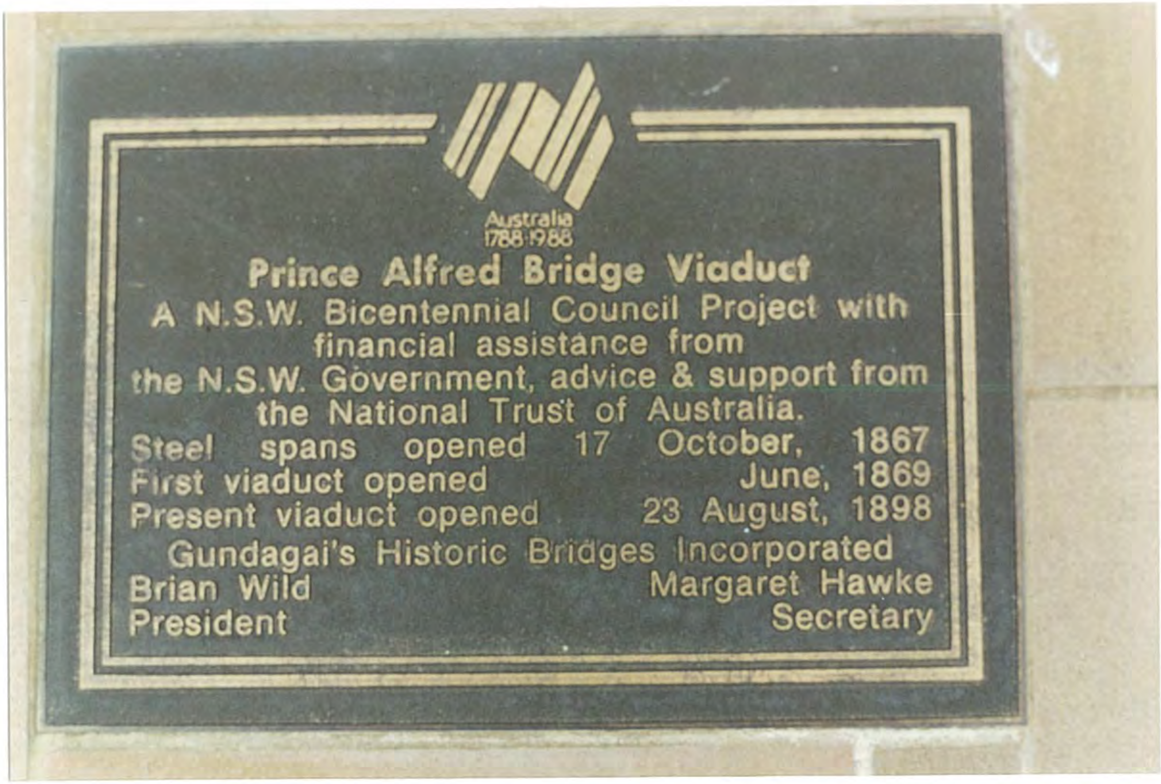
The typical state of the road viaduct at the time it was taken out of service. Each span had been halved by trestles at the mid-spans, the trestles without corbels under the longitudinal girders.

A 10-year campaign ensued with historians and conservationists supporting the local Bridge Preservation Society. In 1987 the "battle" was won when it was accepted as a Bicentennial (1988) project and a total of $210,000 was granted to the Gundagai Historic Bridges Inc. However, the interest from this investment has been insufficient for long-term maintenance despite the cooperation of volunteers and a local bridge gang. Photographs of commemorative information and of some repair work are shown on the next two pages.

The whole historic structure is on the National Estate and has been Classified by The National Trust (NSW). Therefore, the surviving viaduct, under the control of Gundagai Historic Bridges Inc., is included in the plaquing nomination.

During preparation of this nomination report, Gundagai Historic Bridges Inc made application for a special Bicentenary of Federation Grant of around $3 million to enable a more thorough rehabilitation of the historic viaduct to be undertaken.

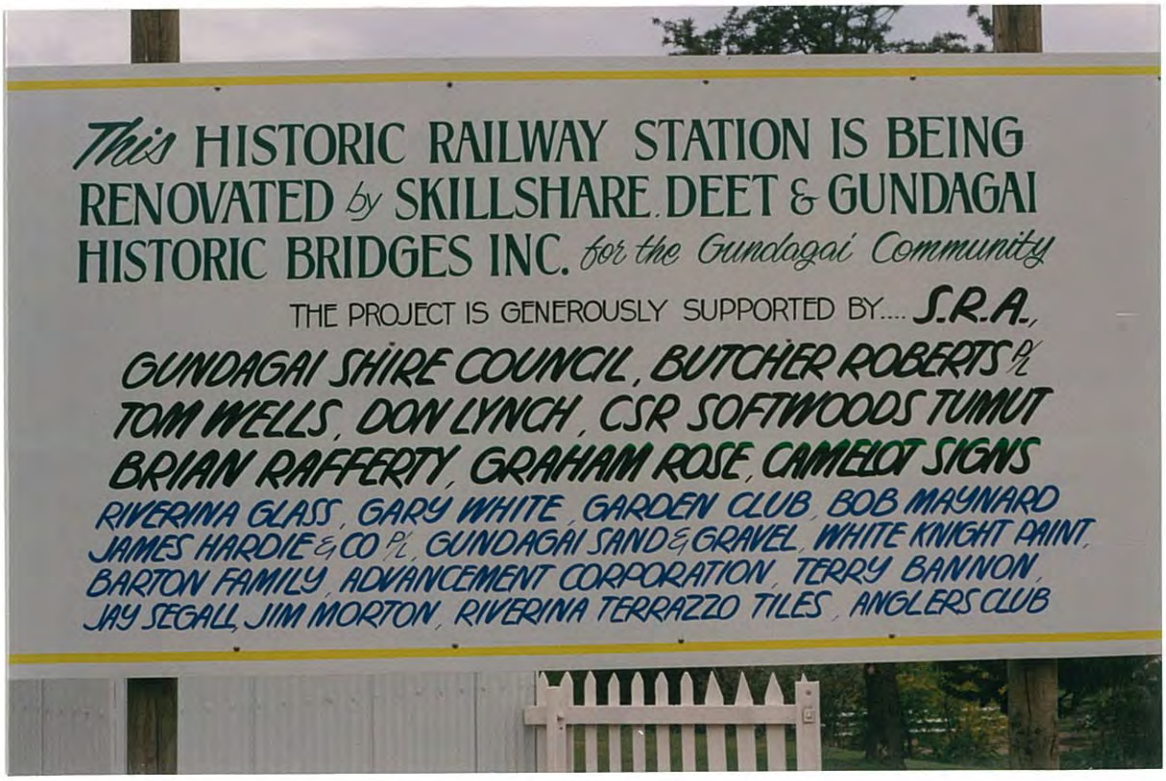




Information board and plaque at the northern end of the viaduct.

Deck repairs undertaken during the early 1990s.

THE RAILWAY CROSSING



The railway reached Gundagai in 1886 as a branch line from Cootamundra on the main Sydney-Melbourne line. There was this handsome timber station building but no major earthworks or bridges on the 34 miles (54 kms) line. It cost £161,378.

On 21st July, 1886 a Ministerial party arrived from Sydney on a special train and a banquet for 200 guests was held in the goods shed. It was a typical festive occasion. But it was always intended that the line should go on to Tumut.

The historic goods shed at Gundagai, venue for the 1886 banquet.

Politicking and planning continued during the next 14 years until in 1900 the 31 mile (51 kms) extension was approved to be built by the Railway Construction Branch of the Department of Public Works using day labour at an estimated cost of £161,181 or £5,200 per mile. The line opened on 12th October 1903 amid great fanfare and the presence of the Governor Sir Harry Rawson, Premier Sir John See and E W O'Sullivan, Minister for Public Works, and a gathering of 8,000 visitors and locals. Among the festivities at Tumut was a race meeting and a banquet.

At that time the general standard for branch line construction was minimum earthworks, small timber bridges, lightweight rails, widely spaced sleepers and no ballast, called Pioneer Line construction where costs could be as low as £3,000 per mile. If the line proved profitable it could be upgraded. Pioneer Line policy also excluded major bridges, which could be very expensive thereby increasing initial costs and interest on the capital which in turn reduced overall profitability.

Unfortunately, the policy could not be applied at Gundagai because it soon became obvious that the preferred route to Tumut meant crossing the Murrumbidgee River adjacent to the existing road crossing with a similar structural arrangement - a long timber viaduct and a large steel truss over the river, which would be a high item of expenditure. The final cost of this railway crossing has been estimated at £41,000 (only £3,000 more than the road crossing) which meant the $\frac{5}{8}$ mile railway structure represented 25% of the total cost or equivalent to 8 miles of railway.

For the timber viaduct, the railway design engineers (Harvey Dare, J J C Bradfield and J W Roberts) chose the deck Howe truss (an American style) as used by Percy Allan for the approach spans of the new Pyrmont Bridge in Sydney. But in order to contain costs they eliminated the cast iron connecting plates at all joints and used a combination of checking one timber into another, and inserting timber chocks, see below. The imposing high-level viaduct contains 75 of these 35-foot trusses with another five on the South Gundagai side of the river bridge. It is the longest timber truss viaduct ever built in Australia, photographs next page.

The timber truss railway viaduct at the Gundagai end. As a cost saving measure the timber joints at the ends of the members are shaped or scarfed so as to fit together thereby transferring the structural forces. On timber truss road bridges these joints incorporated expensive cast iron plates to ensure a good fit.

Top *A typical timber truss span of the railway viaduct, revealing its details and showing its dominance over the timber beam road viaduct* and below *the high-level railway viaduct "marching" across the flood plain.*

The railway timber viaduct and the steel truss over the Murrumbidgee River.
The maker's plate is attached to the end steel post on the right hand side.

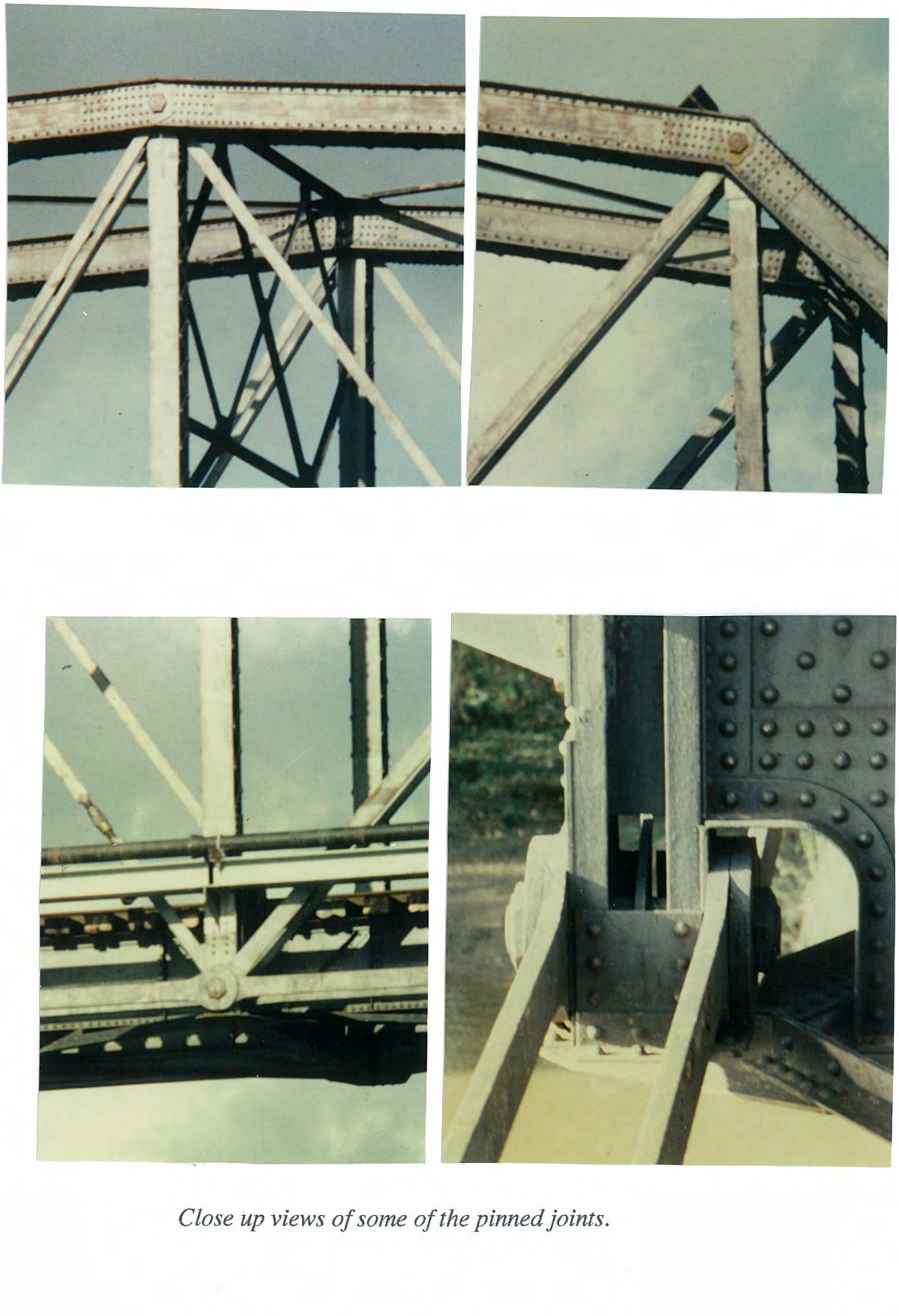
For the river bridge, the railway engineers opted for a single span rather than have piers in the river which set the span at 200 feet. It was a time of technical change in large-span bridges in New South Wales with the introduction of American bridge technology. Designers were still going through a transition stage of deciding whether to use the American system of pin-jointed trusses or the British practice of riveted joints. The former were cheaper in terms of fabrication and erection, hence initial costs were low which was attractive to the supplier of the capital funds (the NSW Government), but the system was not amenable to future strengthening. The riveted trusses were dearer but were more easily strengthened. The steel railway truss bridge immediately preceding the Gundagai bridge was the 180-foot span over the Gwydir River on the Inverell line, it was riveted, whereas at Gundagai the designers chose a pin-jointed truss and an American company, the Union Bridge Co., won the contract to supply the bridge.

However, it was a subsidiary company, A & P Roberts, Pencoyd Iron Works, Pennsylvania, USA who supplied the truss components, their maker's plate is shown on the next page. The truss was erected by PWD day labour on conventional falsework on timber trestles in the river. At very low water today, the stumps of the piles can be seen.

The maker's plate on the steel railway truss at Gundagai.

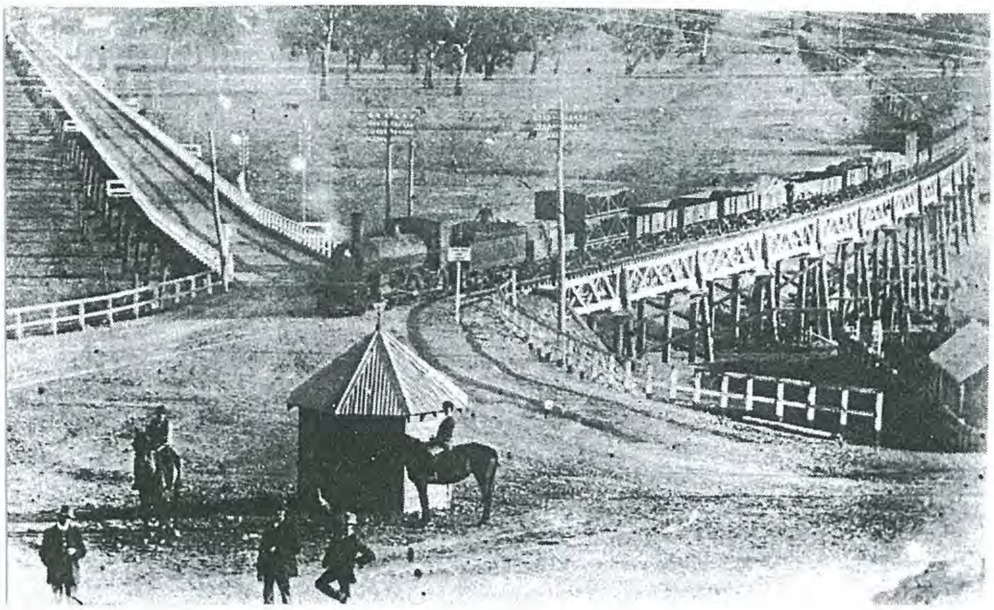
The steel truss is a typical American hog-backed pin-jointed Pratt truss in which the pins at each joint are almost 6 inches in diameter. The truss is flanked at each end by a steel plate web girder of 66 feet span. Total length of the railway crossing is 3340 feet (0.63 mile, 1.01 km).

The hog-back style of the Gundagai railway truss flanked by its plate web girders. The pins can be more clearly seen in the top chord but are also in the bottom horizontal member.



Close up views of some of the pinned joints.

There appears to be only 3 surviving pin-jointed trusses in New South Wales either in service or a least still in place as constructed. The 1879 Whipple truss bridge over the Shoalhaven River at Nowra carries the southbound carriageway of the Princes Highway, while the other 2 are uniquely at Gundagai, the 1867 Prince Alfred Bridge which is still in service and the 1903 railway truss which is not in service due to the railway from Cootamundra to Tumut being closed in 1985.



Top *A scene c1910 when all the Gundagai Historic Bridges were in use* and below *the scene today with the two timber viaducts still a dominant feature of the flood plain landscape.*

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Bridges Down Under

The History of Railway Underbridges
in New South Wales

by Don Fraser

AUSTRALIAN RAILWAY HISTORICAL SOCIETY
New South Wales Division

Although not officially stated, it is fair to assume that the planners of the railway xtensions recognised that a limited number of expensive bridges was acceptable within the nillion-pound budgets for the new lines, because, of the nine to be completed by the end of 3, three had steel truss bridges. The first, as we have seen, was at Gravesend on the Inverell e. The second was the 1902 Goulburn-Crookwell Line which had to cross the Wollondilly iver soon after leaving Goulburn. Thirty-three years earlier, Whitton had used massive rought iron girders imported from England to carry the Main South across this river a few es downstream. The Crookwell railway was built to Pioneer Line standards at 4,084 unds per mile and two lightweight steel trusses were built to span the river. Still on site on closed line, they are of mixed "pedigree" being British Warren trusses but in the American e (tall, with cross-bracing well above the traffic), fabricated in America by P. A. Roberts, ncoyd Iron Works, Pennsylvania, but of British riveted construction, not pin-jointed. This ix indicates that experimentation with steel trusses was still going on and it would continue r a few more years until the local bridge designer J. W. Roberts standardised on the riveted tt truss in time for the North Coast Railway.[6]

Official records [7] state that the Union Bridge Company (principal contractors for the Hawkesbury River Bridge) won the contract, through its Sydney agent J. Barre Johnston & Co, deliver the steel work "in ships slings" to Sydney. However, in America at that time J. P. rgan had formed the American Bridge Company and bought up 24 other bridge ompanies including the Union Bridge Company and the Pencoyd Iron Works. [8] The Wollondilly bridge contract appears to have been either transferred or sub-let from the mer to the latter company under the umbrella of the parent company. The trusses were cted by PWD day labour and a temporary bridge was built to enable the line construction proceed. In fact the original estimate for the line provided for a timber bridge but Henry eane considered that an iron bridge would be cheaper in the long term. Also on this branch e was another American truss, a modest timber deck Howe truss over Pegar Creek. It too vives unused.

More timber trusses were built on other new lines such as the 1903 Dubbo-Coonamble e. Before it could wend its way north along the western side of the Castlereagh River it l to cross the Talbragar River just out of Dubbo. A viaduct of short-span timber openings as inappropriate for the main channel crossing so two 62-foot through Howe timber trusses ere used in keeping with Pioneer Line policy. Timber trusses were also used to fill the span ige between the short timber girder bridges and the longer plate web girders and large el trusses. The 1903 extension of the railway from Gundagai to Mount Horeb, on the umut Line, had all three as it crossed the flood plain and the main channel of the urrumbidgee River. The general pattern for the railway crossing had been set by the road ssing in 1867, a long timber viaduct over the flood plain and two metal trusses (the Prince fred Bridge) with a pier in the middle of the main river channel. However the detail of the ailway crossing was quite different. Instead of cluttering the flood plain with 112 debris-ching 24-foot timber openings, a viaduct of seventy-seven 35-foot timber deck Howe sses was constructed at a higher level, and a single 200-foot steel truss, flanked by 68-foot rough plate web girders, was built clear across the main channel.[9] The whole crossing is an

6 J. W. Roberts 'Recent departmental practice in the design of steel railway bridges required for the waterways of the North Coast Railway, NSW, including some notes on their manufacture' *Syd. Uni. Engg. Soc., Proc.*, vol.15, 1910-11, pp. 75 – 100.

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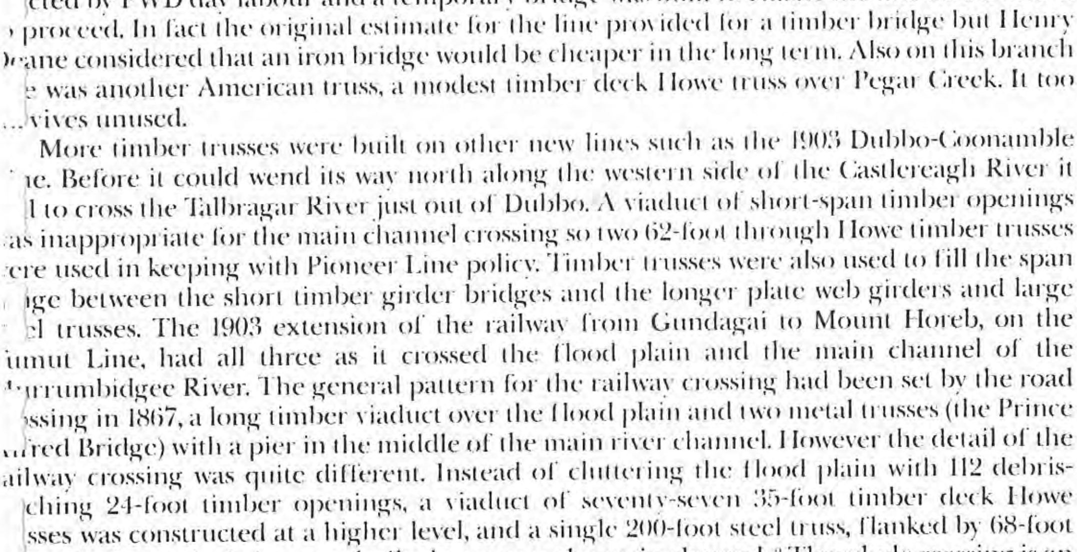


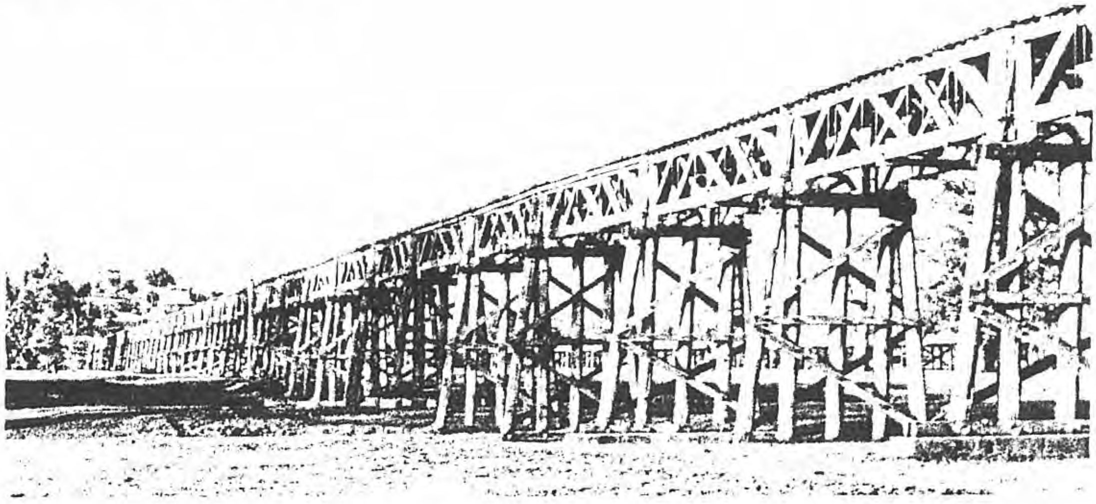
The Wollondilly River at Goulburn was another river that had to be crossed by long-span bridges in order to provide ample waterway for floods. Although these two trusses on the Crookwell Line were an American design, they are British riveted Warren trusses. The W pattern of diagonals, which is typical of a Warren trusses, is confused here by the vertical members which are used to support the long top compression members against buckling.
(Don Fraser)

TABLE 5 - RAILWAY STEEL TRUSSES 1892 - 1925

Year	Location	No	Span feet	(m)
1892	Yass River, Yass	1	200	(61)
1894	Leycester Creek, Lismore #	3	120	(36.6)
	Coopers Creek, Bexhill #	1	120	(36.6)
	Wilsons River, Eltham #	1	120	(36.6)
	Pearces Creek, Pearces Cnr #	1	120	(36.6)
	Dunbible Creek, Dunbible #	1	120	(36.6)
1898	Ironbark Creek, Sandgate (r)	1	110	(33.5)
	Styx River, Newcastle (r)	1	73	(22.4)
	Liddell Creek, Liddell (r)	1	73	(22.4)
1901	Gwydir River, Gravesend	2	180	(54.9)
1902	Wollondilly River, Goulburn	2	120	(36.6)
	Hunter River, Singleton (r)	5	90	(27.5)
1903	Murrumbidgee River, Gundagai	1	200	(61)
1905	Richmond River, Casino *	1	180	(54.9)
1906	Namoi River, Manilla	2	180	(54.9)
1907	Nepean River, Penrith (r)	1	120	(36.6)
		4	193	(58.8)
1908	Glennies Creek, Glennies Creek (r)	4	129	(39.3)
1911	Hunter River, Oakhampton *	3	157	(48)
	Paterson River, Paterson *	1	200	(61)
	Parramatta Road, Homebush	2	73	(22.2)
1912	Ironbark Creek, Sandgate	1	126	(38.4)
	Parramatta Road, Lewisham	1	111	(33.8)
1913	Williams River, Dungog *	1	120	(36.6)
	Karuah River, Stroud Road *	1	120	(36.6)
	Avon River, Gloucester *	1	120	(36.6)
	Manning River, Mt George *	4	200	(61)
	Charity Creek, Mt George *	1	120	(36.6)
	Rocky Falls Creek, Mt George *	1	120	(36.6)
	Dingo Creek, Wingham *	1	120	(36.6)
	Gwydir River, Moree	2	120	(36.6)
	Mehi River, Moree	1	120	(36.6)

Year	Location	No	Span feet	(m)
1913	Hunter River, Muswellbrook	1	157	(48)
1914	Boomi River, Mungindi	1	120	(36.6)
1915	Dawson River, Taree *	1	120	(36.6)
	Lansdowne River, Lansdowne *	1	120	(36.6)
	Stewarts River, Johns River *	1	120	(36.6)
	Camden Haven River, Kendall *	1	200	(61)
	Bellinger River North Arm, Raleigh*	3	157	(48)
	Bonville Creek, Bonville *	2	120	(36.6)
	Sherwood Creek, Kungala *	1	120	(36.6)
	Argyle Street, Moss Vale (r)	1	133	(40.5)
1916	Styx River, Newcastle (r)	1	73	(22.4)
1917	Hastings River, Wauchope *	3	157	(48)
	Wilson River, Telegraph Point *	2	157	(48)
	Cooperabung Ck, Cooperabung *	1	120	(36.6)
	Pipers Creek, Kundabung *	1	120	(36.6)
	Macleay River Kempsey *	3	200	(61)
	Wybong Creek, Sandy Hollow	1	157	(48)
1918	Lachlan River, Forbes	1	157	(48)
	Talbragar River, Elong Elong	1	120	(36.6)
1920	Railway Parade, Rozelle	1	90	(27.4)
	The Crescent, Annandale	2	108	(32.9)
	Wentworth Park Road, Glebe	1	75	(22.9)
1921	Coxs River, Wallerawang (r)	1	57	(17.4)
1923	Nambucca River, Macksville *	2	157	(48)
	Bellinger River South Arm, Raleigh*	3	200	(61)
1924	Orara River, Glenreagh	1	157	(48)
	Prospect Creek, Carramar	1	120	(36.6)
1925	Macquarie River, Dubbo	2	120	(36.6)
	Illawarra Lines, Sydenham	1	123	(37.5)
	Total	60		

= Murwillumbah Line * = North Coast Railway (r) = replacement bridge



Crossing the wide flood plains of many inland rivers required long viaducts. Often they comprised hundreds of timber girder spans. Here at Gundagai, 77 timber deck trusses were used to achieve a clearer waterway for the Murrumbidgee River. **(Don Fraser)**

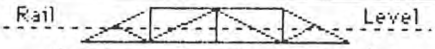
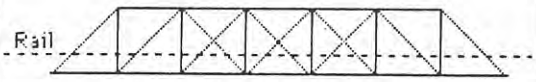
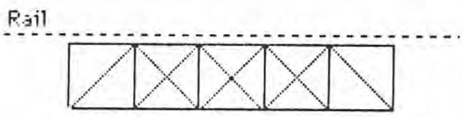
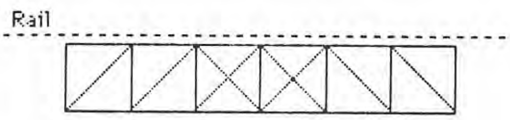
Opposite *A working drawing for a typical timber deck truss, signed by Engineer-in-Chief Henry Deane.* **(SRA Archives)**

excellent demonstration of the application of American technology to both timber and metal trusses, and uniquely at the same site.

Currently the line is closed but the viaduct and river crossing are intact. The timber deck trusses are American in style (Howe trusses) but made from Australian hardwoods using local labour. The steel truss is wholly American in style, design and fabrication by the same supplier of the Crookwell Line trusses at Goulburn. At Goulburn they used parallel-chord riveted Warren trusses whereas at Gundagai they reverted to American practice with a non-parallel chord (polygonal or hog-back) Pratt truss, pin-jointed. It was still a period of experimentation. The truss was erected on temporary timber staging supported by piles driven into the river bed using PWD day labour. Construction of the viaduct and bridge delayed the opening of the line by two years. The cost of the whole crossing at around 25,000 pounds represented a massive 17% of the line cost from Gundagai to Tumut which was built to Pioneer Line standards at 2,936 pounds per mile, so the crossing of half a mile was equivalent to about eight miles of railway.

Right *Pinned joints and eye-bars for the bottom chord tension members were standard features of American trusses. The railway truss at Gundagai and the road bridge at Nowra are excellent examples of this form of construction.* **(Don Fraser)**

TABLE 6 TIMBER RAILWAY TRUSSES - POST 1890

TYPE	LOCATION	SPANS No - Feet	BUILT	REPLACED
 European - through - transom top	Byron Creek Casino - Murwillumbah	3 - 42	1892	1933
 Howe - through - transom top	Namoi River Narrabri Jct - Moree	3 - 62	1896	1978
	Narrabri Creek Narrabri Jct - Moree	1 - 62	1896	1980
	Tarrion Creek Byrock - Brewarrina	6 - 62	1901	1949
	Bungabbee Creek Casino - Murwillumbah	1 - 62	1903	1949
	Bungabbee Creek Casino - Murwillumbah	5 - 62	1903	1962
	Namoi River Narrabri Jct - Walgett	3 - 62	1903	1945
	Talbragar River Dubbo - Coonamble	2 - 62	1903	1981
	Saltwater Creek Grafton - Casino	1 - 62	1905	1926
	Myall Creek Grafton - Casino	1 - 62	1905	1926
	Myrtle Creek Grafton - Casino	1 - 62	1905	1926
	Deep Creek Grafton - Casino	1 - 62	1905	1926
	Two Mile Creek Narrabri Jct - Walgett	3 - 62	1908	
	Cudgegong Creek Mudgee - Gulgong	2 - 62	1909	
	Belubula River at Canowindra	1 - 62	1910	
	Talbragar River near Dunedoo	2 - 62	1917	1987
 Howe - deck - transom top	Kellys Gully near Warialda	3 - 40	1901	1910 washaway
	Pegar Creek Crookwell Line	1 - 32	1902	
	Murrumbidgee River at Gundagai	77 spans 32 - 35	1903	
	Borah Creek Barraba Line	3 - 34	1908	
	Oakey Creek Barraba Line	5 - 34	1908	
	Alipou Creek South Grafton Yard	1 - 35	c1920	c1990
 Howe - deck - transom top	Coolbaggie Creek Coonamble Line	2 - 38.5 1 - 40	1903	c1955
	Wialdra Creek Near Gulgong	3 - 40	1910	1987
	Boorowa River Galong - Boorowa	3 - 40	1915	

The First Sixty Years of Metal Bridges in New South Wales

D J FRASER, M.I.E.AUST

SUMMARY Prior to the recent advent of box girder construction in steel or prestressed concrete, bridge spans in the range of 50m to 150m were dominated by the steel truss, the most common form being the American Pratt truss. This situation prevailed in New South Wales from the beginning of this century, but was not the case in colonial times. In the second half of the nineteenth century, bridge engineers in New South Wales used British technology, consequently, iron cellular and iron lattice girders were the standard types of bridges adopted for crossing major rivers. This paper traces the evolution of metal bridges in New South Wales during the period 1863 - 1925, and focusses attention on the technical and non-technical factors that led to the rapid changeover from British to American bridge technology after 1890.

1 INTRODUCTION

Until 1916 when the steelworks at Newcastle were established, iron and steel structural sections and plates were expensive imports for New South Wales. Consequently, metal bridges were very expensive projects. Costs could be between three and five times that of a timber structure, occasionally a lot more. Metal bridges were, therefore, used sparingly, starting in 1863.

Table I shows that timber bridges outnumbered metal bridges by about eight to one prior to 1916, but the complete reverse was the case in the 1920's when steel girders and trusses dominated the construction of most bridges. By then, the technical superiority of metal bridges was well established for a wide range of spans, figure 1. This situation was further enhanced as the supply of cheaper local steel steadily increased.

For much of the period under review, 1863 - 1925, the construction of railways and roads absorbed most of the funds allocated to public works, figure 2. The railway vote in particular averaged over 50% with peaks in excess of 60% during the boom years of the 1880's.

Despite the lion's share of public works funding, the railway and road engineers were under intense pressure to minimise costs especially for bridges, hence the extensive use of timber, so much so that New South Wales became known as "the timber bridge colony" (Fraser 1985). Proposals for metal bridges were the subject of detailed examination and often lengthy debate in the New South Wales Parliament. On one occassion, in 1861, the Legislative Assembly refused to vote money for the bridge over the Hunter River at Singleton until John Whitton tabled the plans showing that timber laminated arches would be built (Royal Commission on Bridges 1884 - 1886). However, at many sites, large span metal bridges were the best solutions. Under british-trained engineers John Whitton (railways) and William Bennett (roads), the plate-web girder and the lattice-web girder, figure 3, became the standard types of metal bridges in colonial New South Wales.

British technology was dominant until 1890 when Whitton and Bennett retired. Thereafter, a rapid changeover to American technology took place, initially for railway bridges under Henry Deane and then for road bridges, in the early years of Federation, under prominent designers such as Percy Allan and E. M. de Burgh.

TABLE I

SUMMARY OF ROAD AND RAIL BRIDGES BUILT IN NEW SOUTH WALES 1851-1925, FOR SPANS OVER 40 FEET (13m) BUT EXCLUDING ALL TIMBER BEAM BRIDGES.

Period	1851-60	1861-70	1871-80	1881-90	1891-1900	1901-10	1911-15	Sub-total	1916-20	1921-25	Totals
Masonry arches	*1 5	4 8	2 2	- 1	1 4	- 1	- 9	8 30	1 8		9 38
Timber arches	5 4	3 1	1 -	2 2				11 7			11 7
Timber trusses	2 -	25 -	80 -	69 9	108 6	39 13	12 1	335 29	18 1	1 -	354 30
Metal lattice		1 -	4 2	13 10	6 2			24 14			24 14
Metal trusses		2 -	2 -	2 3	1 10	2 7	1 21	10 41	2 8	1 6	13 55
Metal girder		- 7	1 4	2 12	8 11	4 2	- 4	15 40	** **	** **	** **
Opening bridges	1 -	3 -	2 -	9 -	12 -	10 -	1 -	38 -		3 -	41 -
Reinf conc					9 -	14 -	17 -	40 -	**	**	** -
Totals	18	55	99	132	178	92	66	640	**	**	**

* upper figures apply to road bridges, lower figures apply to rail bridges.

** standard designs , locations and dates not fully recorded , exact totals unknown.

Dr D J Fraser is a Senior Lecturer, School of Civil Engineering, University of New South Wales. (Paper G1182 submitted on 12 August 1985).

We are fortunate that most of the iron and steel bridges of the period 1863 to 1923 have survived. They are evidence of an important phase of our engineering heritage.

This paper traces the technical development of metal bridge superstructures in New South Wales against a backdrop of concurrent social, political and economic factors.

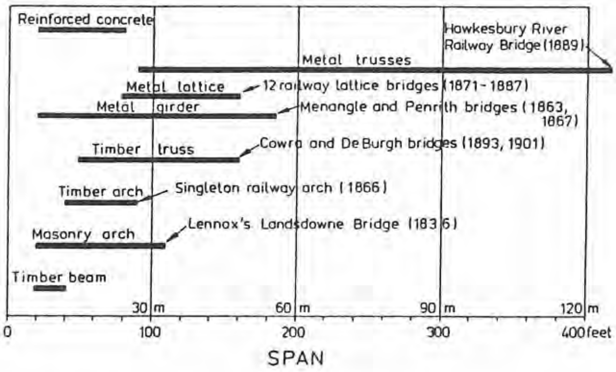


Figure 1 Bar graph showing the economic ranges of spans for the various types of bridges used in New South Wales. The flexibility of application of metal girders and trusses made them the preferred choice, but their costs were very high.

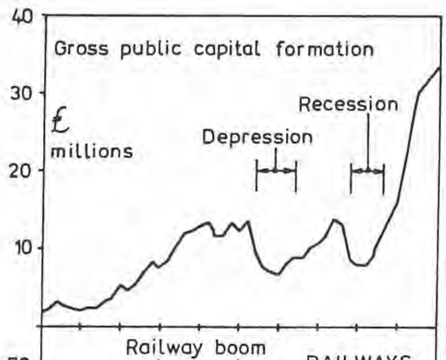


Figure 2 Economic growth, and decline, in New South Wales during the fifty-year period 1865-1915 as indicated by the gross public capital formation (cost of public works). The distribution of that capital shows the dominant position of the railways. (from Butlin 1962).

1.1 BRITISH BRIDGES

Metal bridges in New South Wales of british origin were all built in the late colonial period between 1863 and 1897. The superstructures comprised four basic types, (1) cellular girders, (2) Warren girders or trusses, (3) lattice girders or trusses and (4) plate-web girders, figs 3 to 9. Wrought iron was used almost exclusively. The piers were often of masonry construction but there were many sites where pairs of braced metal cylinders were used, built up from cast-iron rings and filled with concrete.

Cellular girders

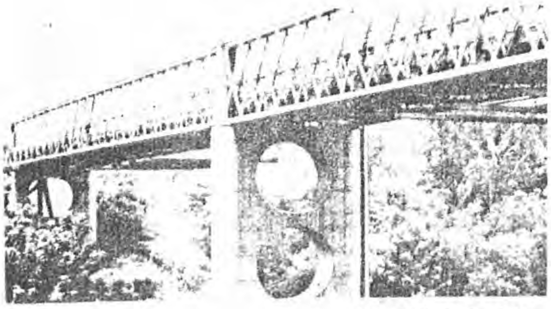
The cellular or tubular girders in New South Wales had their origins in the famous tubular bridges of Robert Stephenson, the Conway (1849) and Brittania (1850) Bridges in Northern Wales, and the Victoria Bridge over the St.Lawrence River, Canada (1860). Only the Conway Bridge survives. The cellular form of construction, figure 4, was developed from a series of model tests by William Fairbairn and the analytical investigations by Eaton Hodgkinson. Their workshowed the superiority of these girders in resisting collapse by lateral buckling.

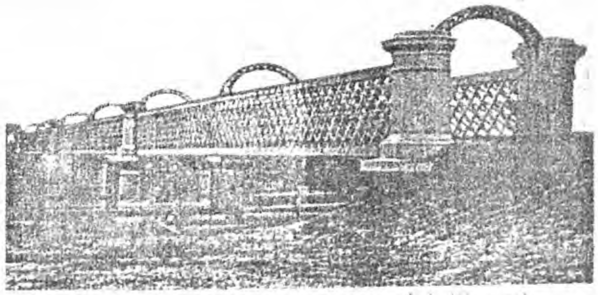
The maximum span of Stephenson's tubular bridges was 460 feet (140m) and this justified the tunnel-like construction, but when John Whitton adopted this arrangement for the first series of major bridges for the railways of New South Wales, the maximum span was only 198 feet (60.5 m). He was therefore able to use shallower girders in the form of pony or half-through bridges, figure 5.

Four of these bridges were constructed, two over the Nepean River at Menangle (1863), figure 6, and at Penrith (1867), and two crossings of the Wollondilly River (1869). The latter were removed in 1914 when the Main Southern Railway was duplicated on a new alignment. The Menangle Bridge is still in use as a railway bridge but the spans have been halved by additional piers built in 1928. The Victoria Bridge at Penrith was originally designed for double track railway but was shared by road traffic and a single track for its first forty years. In 1907, heavy-duty double-track were completed immediately downstream and the Victoria Bridge has been used only for road traffic ever since.

The Wollondilly bridges were simply-supported girders and only had cellular construction for their top flanges, whereas the Menangle and Penrith bridges were three-span continuous with both flanges cellular throughout. The original designs were by John Whitton but were checked by John Fowler (of Firth of Forth Bridge fame) in London using the relatively new theories of bending, deflection and formulae for predicting points ofcontraflexure. All four bridges were fabricated in England.

Cellular girders were a very expensive form of construction. This can be demonstrated in two ways. Firstly, the Menangle Bridge cost £94,562 in 1863 which in 1984 was equivalent to $6 millions, the conversion is based on a cost index of 0.14 relative to 1967 and a further factor of 4.48 to 1984 (Pope 1984) plus the 1966 changeover to decimal currency. A modern replacement would cost less than half that indexed cost. Secondly, the Penrith Bridge cost £100,000 in 1867 and was replaced in 1907. Its index cost for that year would have been £90,713 (0.14 for 1867 and 0.127 for 1907), whereas the replacement Pratt trusses cost only £38,000.





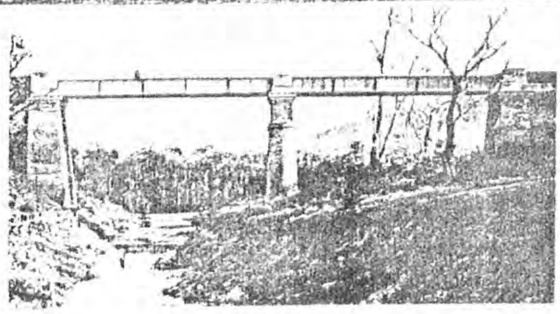
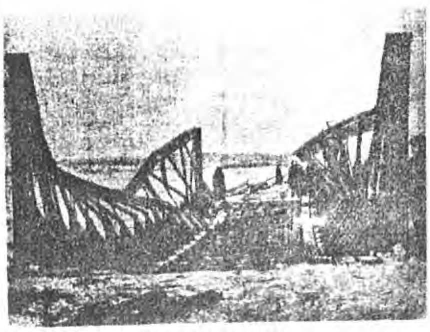


Figure 3 Typical examples of british bridge technology, lattice girders (for road and rail), and the plate web girder. Braced cylindrical piers were preferred and the plated diaphragms minimised the trapping of flood debris.



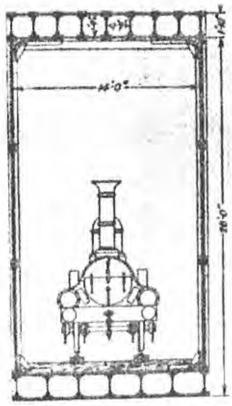


Figure 4 Girders were prone to collapse due to lateral buckling of their compression flanges. Fairbairn and Hodgkinson demonstrated the effectiveness of cellular construction.

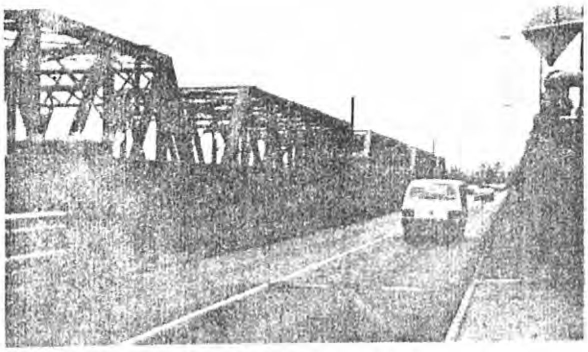
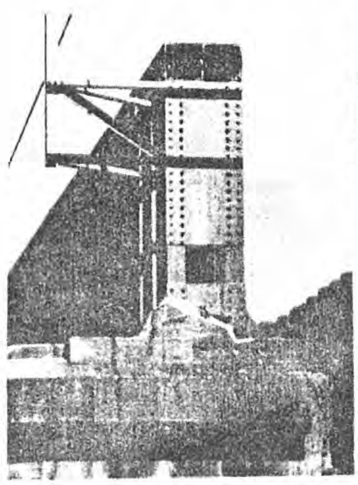


Figure 5 John Whitton's cellular girders were not deep enough to form tubes, hence the half-through or pony construction. Note the adjacent through trusses.



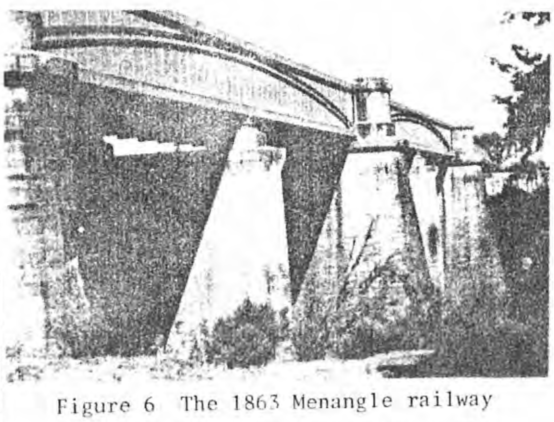


Figure 6 The 1863 Menangle railway bridge and its cellular flange. The arch ribs are purely decorative.

Warren trusses

The first major iron bridge for road traffic in New South Wales was the 1867 Warren or single lattice truss bridge, figure 7 , over the Murrumbidgee River at South Gundagai known as the Prince Alfred Bridge. The bridge is still in use despite the recent deviation of the Hume Highway a mile downstream. The river crossing had become a major obstacle for travellers and teams following the Hume and Hovell route to the Riverina and Victoria, and there had been regular petitions and deputations to the Colonial Government for a bridge.

Successive governments deferred on the grounds of low traffic flows and the high cost of any bridge project to cross the half-mile flood plain, but political and commercial factors forced the Government's hand. The merchants at Wagga Wagga favoured trade with Victoria since that colony's railway had reached Echuca in 1864, and they accused the distant Sydney-based Government of neglect (Ill.Syd News 1864). They formed a joint-stock company and built a substantial three-span timber bridge over the Murrumbidgee River in order to direct traffic from the surrounding districts through the town. It was reported that "as a financial speculation the bridge has proved successful".

A similar bridge had been erected over the Murray River at Albury so the New South Wales Government was forced to act in order to turn the flow of wealth towards Sydney. Not only was a bridge planned but a "Rolls Royce" bridge in the form of an expensive iron structure was approved as a clear indication to the south-western districts of the Government's legitimate interests in those regions.

Initially, only the three-span iron truss bridge over the main channel at South Gundagai was built during 1865-67 at a 1984 indexed cost of $1,850 per m² (3½ times the timber truss rate), and the road continued on the river flats. There was great rejoicing for "one of the noblest structures of the kind in the colony, a triumph of human skills, energy and perserverance over natural obstacles"(Ill.Syd.News 1868). By 1869 the long timber viaduct was completed thereby ensuring a flood-free crossing. The present timber viaduct was built on a new alignment in 1896.

The iron bridge has some unique features as shown in figure 7. The piers are pairs of braced cylinders six feet in diameter, nine feet high, built up from segments bolted together. This form of pier construction set the pattern for nearly all major bridges for the next sixty years. The cast-iron segments were made "in the Colony from Australian iron from the Fitzroy mines" (Bennett 1871). This also set a pattern of progressively more local involvement in the manufacture and supply of bridge components, the construction of foundations and the erection of bridge superstructures.

Each of the Warren trusses is a genuine pin-jointed structure, there is only a single large-diameter bolt at each joint. Bennett chose this system "as requiring least workmanship on the ground,and, from the expedition with which it can be erected, incurring least risk from violent floods". And the support for each truss is a fascinating arrangement, the trusses are supported at the top by a short cantilevered extension of the top chord resting on vertical iron posts projecting up from the piers which finish level with and are connected to the bottom chords of the trusses.

The Prince Alfred Bridge appears to be the only example, in the period under review, of the use of Warren trusses for a road bridge. The merit of this form of construction seems to have been completely over-shadowed by the widespread use of the lattice girder (see next section). The railways too, seem to have used the Warren truss for only one project. the replacement of timber viaducts between Parramatta and Penrith around 1884 (Town and Country Journal 1884, SRA Archive notes for 1888-92).

A series of deck Warren trusses, figure 8, were erected at fourteen locations. They were of local design by G.W.Townsend, 42 feet (12.8m) span, 5 feet 3 inches (1.6m) deep and each complete span weighed 14 tons. Technically, the design was routine and each was a minor bridge project, but at the time they were seen as important indicators of colonial engineering expertise, "built in the Per-Way workshops, the pairs of light girders were subject to a severe test with complete success, demonstrating that girder work can be done in the colony both cheaply and well" (T & C J 1884).

Lattice girders

The lattice girder bridge, figure 3, was almost the exclusive choice for major bridge projects in New South Wales for a quarter of a century, from 1870 to 1895, a period of bridge engineering dominated by the long-serving Chief Engineers John Whitton (railways 1856-90) and William Bennett (roads 1862-89). There were 41 of these standard british lattice girder bridges (27 road, 14 rail Best and Fraser 1982) during their terms of office, but only 12 American style trusses (O'Connor 1983).

The lattice girder was a more economical form of construction than the cellular girders of the 1860's. The latter weighed 0.78 ton/m² and cost $4,500/m² or $6,000/ton (indexed to 1984) whereas the lattice girders weighed 0.4 ton/m² and cost $1,480/m² or $3,700/ton. For comparison timber truss bridges of that period had an indexed cost of between $600 - $1,000 per m².

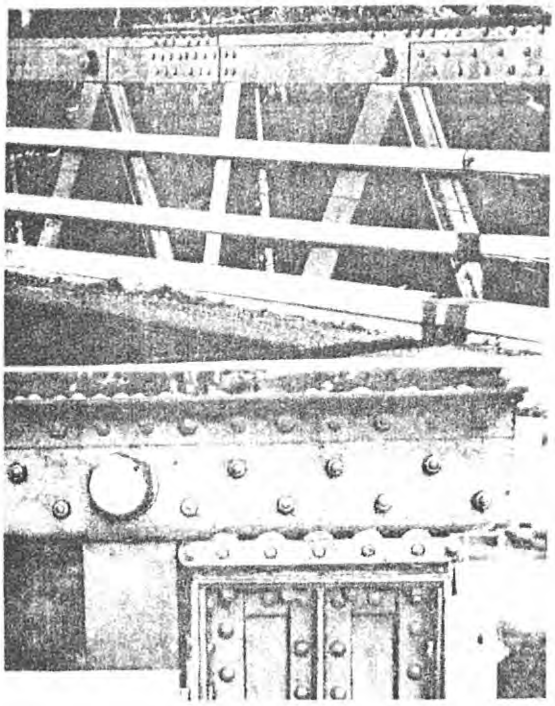
Despite the cost advantage, all lattice girder bridges were fully imported so they were still a relatively expensive form of construction for their day. For example, the 1871 railway bridge over the Hunter River at Aberdeen had an indexed cost of $960,000 when replaced in 1979. The new plate-web girder bridge, designed for much heavier and faster traffic, cost only $550,000.

Railway lattice bridges were of course more substantial than those used for road traffic. The former are all about 4m deep with 7, 6 and 4 triangulations within the lattice web system. Lattice road bridges are only 2m deep and only employ 2 triangulations, consequently, they are sometimes referred to as double Warren trusses.

Although the initial cost of these colonial lattice girder bridges was high, in the long-term they have proved very cost-effective. Nearly all continue in service with an average life of around 100 years. This type of bridge was as much a part of colonial New South Wales as reinforced concrete became to the 1930-60 period and prestressed concrete to more recent times.

Plate-web girders

The iron girder and plate-web girder, figure 9, was essentially a british development, although there was technical input from Europe. The impetus for its development and use came from the Railway Mania, a period in the 1840's in England which saw a frantic rate of railway construction. Masonry arches were too expensive and too slow to build, timber was in



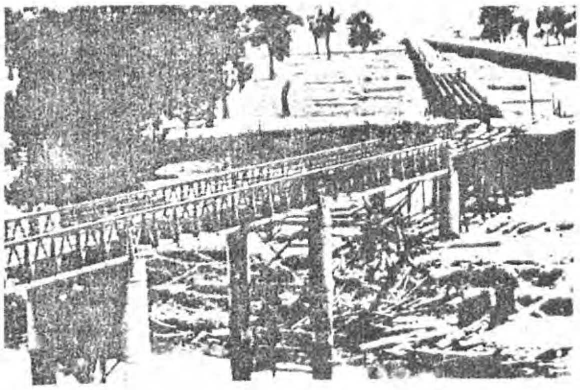


Figure 7 The 1867 Prince Alfred Bridge, Gundagai.

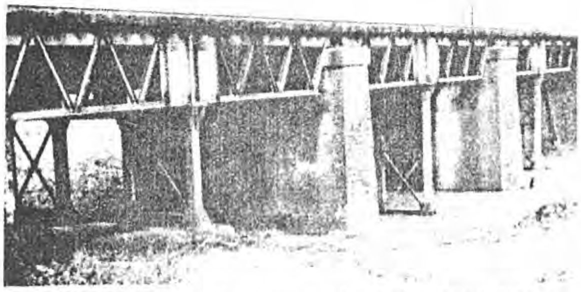


Figure 8 These Warren railway trusses near Werrington are over 100 years old. They were acclaimed as examples of local engineering skills.

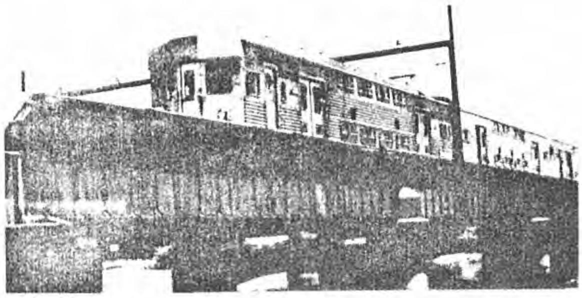


Figure 9 The plate web girder became a standard for medium-span bridges during the 1880's. The 1884 bridge over Cooks River, Tempe, demonstrates the long life of these bridges.

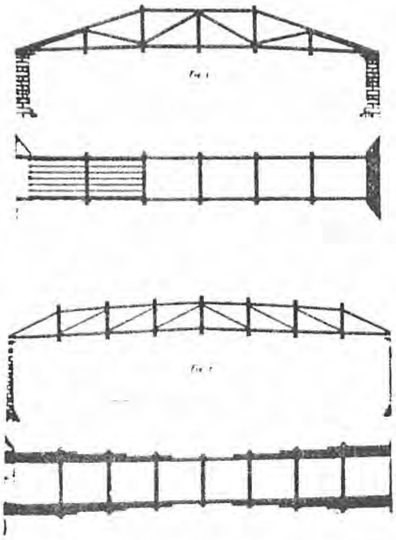


Figure 10 Palladio timber trusses c1550

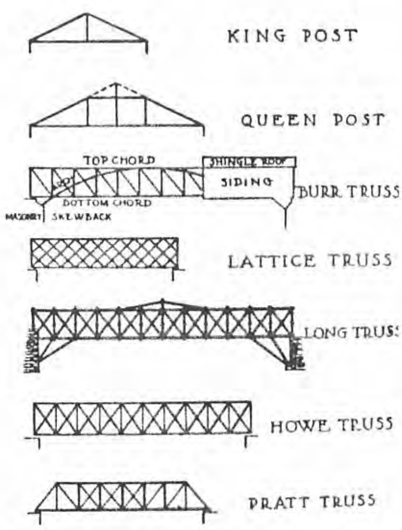


Figure 11 American timber truss bridges of the 1850's. The Howe, Pratt and later the Whipple trusses proved to be economical and durable when adapted to iron and steel construction.

very short supply and its structural forms (solid girders and queen post trusses) were of limited structural capacity.

Metal bridges were the solution, and , at that time, Britain had a rapidly expanding iron industry so was able to meet the demands of the Railway Mania for relatively cheap bridges that could be quickly fabricated and erected. The first of the metal girders were made from cast-iron, and featured enlarged tension flanges to account for the tensile weakness of cast-iron. But cast-iron also had low impact resistance and there was a spate of bridge failures. The solution to impact brittleness was the use of the ductile, but more expensive, wrought iron. This higher quality material enabled girder shapes of more slender proportions to be used which, in turn, exposed the bridge to the dangers of lateral buckling failures, figure 4.

Fairbairn and Hodgkinson analysed the problem of buckling of compression flanges and carried out a series of model experiments. Their work culminated in the tubular and cellular forms of construction noted earlier.

By the time John Whitton was planning the railway extensions in the 1860's through the Great Dividing Range, the cast-iron girder had been displaced by the wrought iron girder, and Whitton's use of the cellular girder has already been described. At the same time he did use plate-web girders for the shorter spans of the Wollondilly set of bridges,figure3.

During the 1870's, funding for railways in New South Wales was severely restricted, consequently, Whitton was forced to use timber bridges, girder, truss and arch (Fraser 1985). The only exceptions appear to be the iron lattice girder bridges at Aberdeen (1871) and at Bathurst (1876), and the plate-web girder over Solitary Creek west of Lithgow in 1872.

In the 1880's, however, the situation was quite the opposite as New South Wales experienced its own form of Railway Mania. The length of completed railways trebled as the main lines were pushed to the distant borders at Albury (1883) and Wallangarra (1888), and to Bourke in 1885 to divert the wool from the river trade to Sydney.

For medium spans in the range 15-30m (50-100 feet), the iron plate-web girder was an ideal transition from the 10m (30foot) timber structures through to the 48.5m (159 foot) lattice girder. It meant that a series of progressively larger spans could be used between the abutments and the main spans over the river channels.

The long-term superiority of the metal girder bridge was soon acknowledged by railways administrators. Since the 1890's there has been a long-standing policy of renewing timber bridges in steel (or concrete) and the steel plate-web girder has become one of the principal types of bridges on all new lines.

As for road bridges, very little use was made of the iron/steel girder by the Public Works Department. Their bridge programme almost exclusively used timber structures, beams and trusses Fraser 1985). Where lattice girder bridges were used, the approach spans were nearly always timber.

2 AMERICAN BRIDGES

The American influence on bridge engineering in New South Wales, at the end of the colonial period and in the first twenty years of federation, was almost entirely through the truss form of construction.

The truss was not an American invention. It had been used in Britain and Europe since Medieval times , mainly for roof trusses. Palladio c1550 had demonstrated the concept of a timber truss bridge,figure 10, but due to the demands for wood by ship builders, the iron industry for charcoal, and for domestic heating, relatively few timber bridges were built. Britain and Europe relied on the masonry arch and gradually changed over directly to metal bridges.

In America, the situation was the reverse, an iron industry in its infancy plus high costs for the imported product, few skilled workers for masonry construction, but most importantly, an almost infinite supply of timber. Consequently, timber bridges dominated American bridge engineering until the 1860's. Figure 11 shows some American timber trusses.

There were about twenty viable designs (Wilson 1871) for timber truss bridges but eventually only two showed all-round suitability. These became the principal types in New South Wales after 1892, The Howe truss for timber road bridges and the Pratt truss for steel railway bridges.

By the 1870's the American iron and steel industry had become established and the logical step of making all-metal trusses occurred. As with timber trusses, there was a great variety of styles. The Whipple and the Pratt trusses became the most popular in New South Wales, particularly the latter. It became the standard for long-span bridges, road and rail, during the first half of the twentieth century. This dominance started in 1892 but three bridges built during the previous twelve years had indicated the pending changeover.

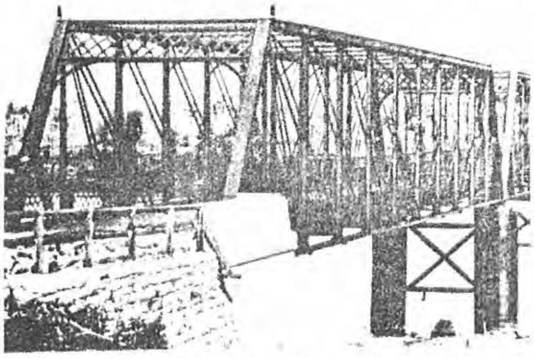
American bridges pre-1892

The three American-style bridges that began the tide of change from British to American technology are shown in figure 12. A characteristic feature of American metal trusses, as used with each of these bridges, was the pin-jointed construction. It consisted of a large-diameter pin at every joint and, multiple eye-bars for the tension chord and diagonal members, figure 13. The reasons for this method of construction were (1) to eliminate the problem of quality control of field rivetting and (2) reduce assembly/erection times. For example, a 100m (300 foot) truss was completed on a site in America in 36 hours.

A span of the Shoalhaven River bridge was on display at the International Exhibition held in Sydney in 1879, and the Judges acknowledged "that this type of bridge can be put together with great rapidity" which was clearly demonstrated on site, figure 13, when a typical span was assembled and floated into place in 4½ days (Town & Country Journal 1880).

Another feature of the American-style metal truss that was in marked contrast to the British lattice girder, was its height and light-weight appearance. The American truss towered over the vehicles using the bridge. It was truly a through bridge with horzontal bracing between the top chords and portal frames at the ends. The lattice girder was too shallow for this treatment and was part of the family of bridges referred to as pony/half-through bridges.

In the case of the Shoalhaven River bridge, the American design showed a significant cost advatage, £24,709 as against £35,758 for a lattice bridge. But such was the strength of British attitudes that the Judges concluded that "taking all different points into consideration, that unless under peculiar cir-



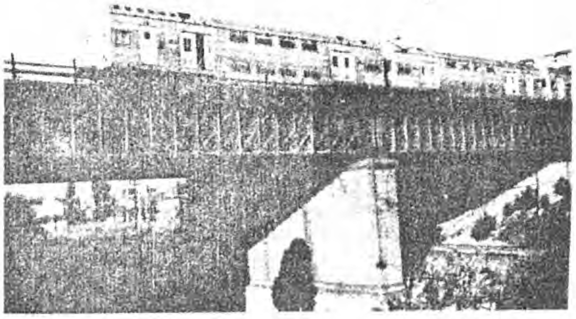


Figure 12 Three early American trusses in colonial New South Wales, at Nowra (1880), at Lewisham (1886) both extant, and the 1889 Hawkesbury River railway bridge.

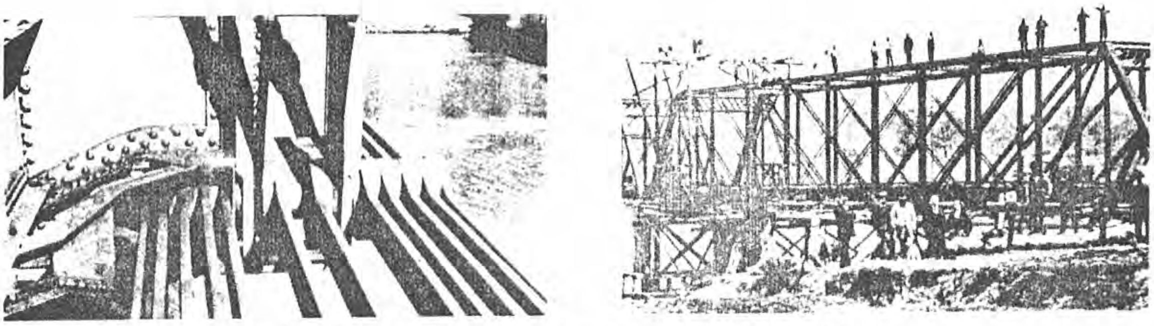


Figure 13 Eye-bars and large diameter pins (left) were a feature of early American metal trusses. At right is the erection of a Whipple truss at Nowra.

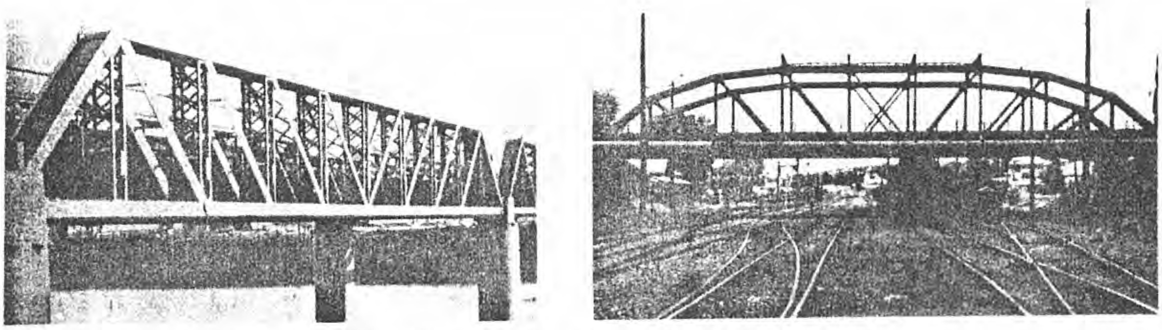


Figure 14 The 1870 Denison Bridge and the 1888 Rocket Street bridge, both in Bathurst. Their success did not hasten the introduction of American bridge technology.

cumstances, the lattice bridge is preferable for both railways and roads in this Colony". The introduction of American bridge technology was virtually blocked for another decade.

But there were two important exception for railway bridges. Firstly, the original stone arch viaduct over Long Cove Creek, Lewisham, was replaced by Whipple trusses in 1886. This type of work was the resposibility of the Existing Lines Branch under George Cowdery who had no time for Whitton and his set ways. Indeed, it was a petty squabble between them in 1883 that precipitated the Railway Bridge Inquiry of 1884-86.

The other exception was the first Hawkesbury River bridge, the largest bridge project in New South Wales prior to the Sydney Harbour Bridge. Whitton had proposed a series of lattice spans, but the sheer magnitude of the work together with criticism of Whitton's autocratic manner caused the Government to seek the advise of overseas bridge experts. Consequently, world-wide tenders were called and the Union Bridge Company of America was the successful tenderer. The bridge was constructed between 1885 and 1889, and incorporated seven pin-jointed trusses of a modified Baltimore design (King & Fraser 1983).

Also, there were two road Pratt trusses. In 1870 , the laminated timber bowstring arches (the Denison Bridge) over the Macquarie River at Bathurst were replaced by iron pony trusses, figure 14. It was a local design by G.A.Morrell and locally fabricated by Peter Nicol Russel and Co. using iron from the Fitzroy Iron Works, Mittagong (Evans 1984). The success of the work, with its high local content, seems to have been ignored at the time. Also at Bathurst is the Rocket Street bridge, figure 14 , over the railway yard and completed in 1888. It is tall enough to have overhead bracing and has a "hog backed" top chord which is another common feature of American truss bridges.

Neither bridge has pinned joints, both are of all-rivetted construction, which highlights the principal objection to pin-jointed construction, namely that despite the simplicity of joint detail and speed of assembly, pin-jointed trusses were difficult to strenghten. Removing the pins destroyed the structural integrity of the joints. Rivetted construction,however, was more amenable to alteration.

Colonial bridge engineers appear to have been aware of these factors because after 1892, with the adoption of Pratt truss bridges, only one pin-jointed bridge was built in New South Wales, the 1903 railway truss over the Murrumbidgee River at Gundagai.

American bridges post-1892

The first railway Pratt truss in New South Wales was built across the Yass River in 1892 to carry a branch line into Yass Town, figure 15. When indexed to 1984 it cost $1,130/m^2 which is 24% less than the cost of lattice construction. In 1894 five similar bridges were completed on the Lismore-Murwillumbah Line, and deck Pratt trusses were built in the Newcastle/Hunter Valley region. All showed the same cost advantage. These bridges set the pattern for major bridge construction in New South Wales into the twentieth century. This technological changeover (from British to American) had two important non-technical factors, one involving a change in administration, the other a change in design personnel.

Firstly, following the dispute between Whitton and Cowdery, the Railway Bridge Inquiry, and the open hostility betwee Whitton and Commissioner Goodchap, the Railway Construction Branch was transferred to the Public Works Department in 1888. Secondly, John Whitton retired in 1890 and was succeeded by Henry Deane. Then William Bennett died and Robert Hickson was appointed Commissioner for Roads and Bridges.

Both new appointees were actively involved with contemporary learned societies such as the Engineering Society of NSW, the Sydney University Engineering Society and the Royal Society, as were many of their colleagues. Collectively, they constituted a new breed of engineers who were more in touch with overseas engineering developments. For the next thirty years, bridge design was in the hands of such prominent engineers as Percy Allan, E.M. deBurgh, Harvey Dare, J.W. Roberts and J.J.C. Bradfield.

The greatest boost to the use of American Pratt trusses came with the construction of the North Coast Railway from Maitland to Casino during the period 1911 to 1923. In all, there were twenty-two crossings of major coastal rivers and their tributories, involving large-span Pratt trusses, figure 16. J.W. Roberts' 1910 paper is an excellent summary of all aspects of bridge design and construction for that project.

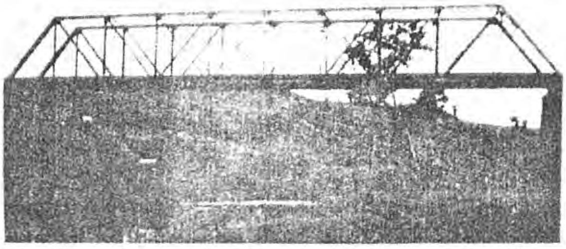
A programme of bridge renewals and of providing new bridges on deviations, duplications and new lines added many more steel Pratt trusses. The weight and speed of steam locomotives left little choice, so much so, that of the 56 iron/steel trusses built between 1892 and 1925, only five were road bridges (O'Connor 1983), figure 16. The local engineers modified the American designs in a number of ways, the most obvious being the elimination of pin-joints and eye-bars for the bottom tension chords ; rivetted-gusseted joints and built-up sections were used instead. Another change was from double flats for tension diagonals, figure 17, to rolled sections or built-up sections.

Local contractors and fabricators became more involved, figure 18, with bridge projects to the extent that all the North Coast Railway bridges were fabricated by Sydney-based firms such as Clyde Engineering Co., Sydney Steel Co., R.L. Scrutton and Co., R. Tulloch and Co. and the Railway Workshops; also, the Government Dockyards at Newcastle. However, most of the steel was imported, but this gradually changed to local supply once the steelworks at Newcastle was established in 1916.

There was also a change in design philosophy, or rather, a return to the policy of John Whitton,namely, "build to a high standard even though cost are high, otherwise maintenance, strengthening and replacement costs will reveal the false economies of cheap initial solutions". Consequently, all the Pratt trusses were designed for loads and impact allowances much greater than indicated by the contemporary traffic conditions. The result was a series of large heavy structures, figure 19, that continue to give satisfactory service after 70 or more years.

3 MOVEABLE SPAN BRIDGES

The paper has dealt exclusively with large-span position-fixed bridges for which the iron/steel girder or truss was the only viable solution during the period under review, 1863 - 1923. However,metal spans were used in other bridge situations, particularly for the moveable spans of opening bridges. The size of the moveable span was kept to a minimum consistent with size of river craft and operating effort, so they were comparatively modest. Details have been given in another paper (Fraser 1985).



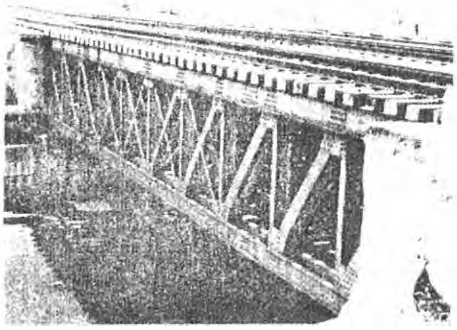
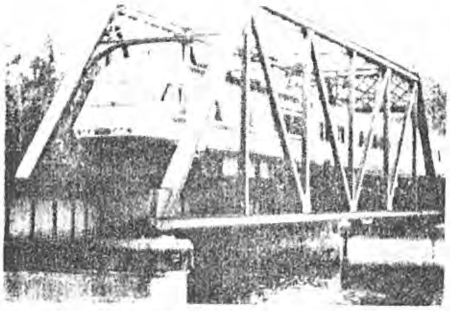


Figure 15 The beginning of a new era, the 1892 through Pratt truss at Yass and the 1898 deck Pratt truss over the Styx River, Newcastle.



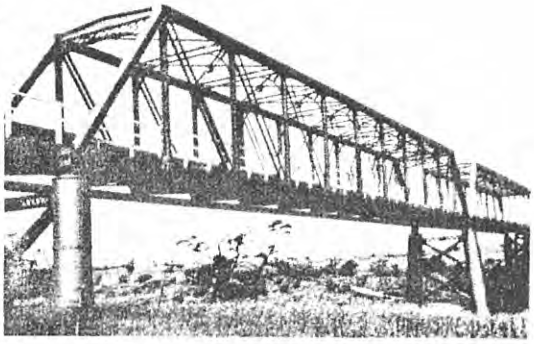


Figure 16 Typical American truss on the North Coast railway (left) and the 1903 Luskintyre road bridge over the Hunter River, Lochinvar.

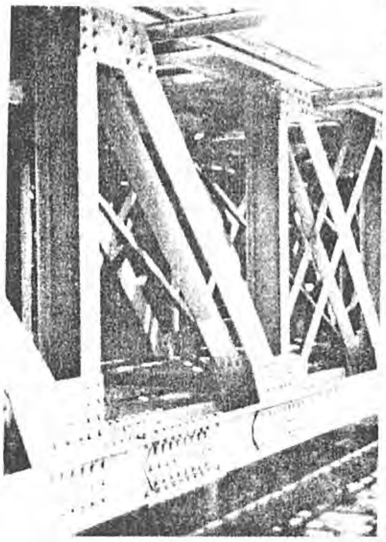


Figure 17 Pairs of flats were used for the tension diagonals in the early Pratt trusses. By 1910 , the North Coast designs had built-up sections and this became standard.

Figure 18 Makers plate on the 1907 railway trusses over the Nepean River , Penrith.

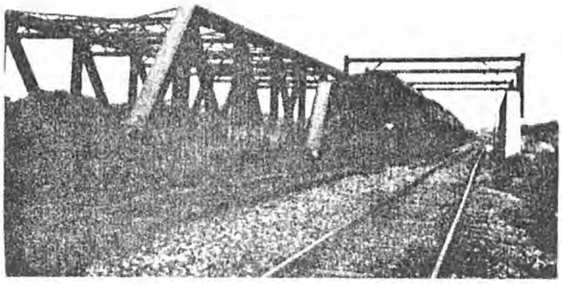


Figure 19 The 1912 through truss (left) and the 1898 pony truss (right) over Ironbark Creek, west of Newcastle.

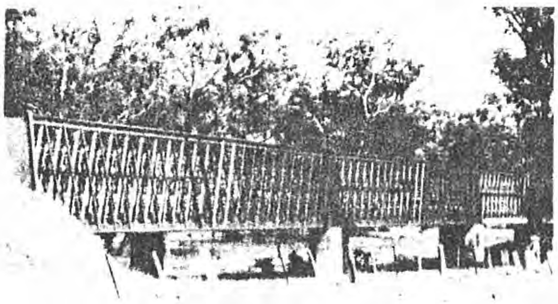


Figure 20 All the spans of the 1882 Iron Cove Bridge have been relocated in the Jemalong Shire. Function and history continue, albeit at a new location.

4 CONCLUSION

The history of the first sixty years of metal bridges in New South Wales had two distinct phases, the British period from 1863 to 1892, and the American period thereafter. The principal type of bridge was different in each period, the shallow girder in the former and the tall truss in the latter. There were advantages and disadvantages with each type so that by 1900 , engineers had decided on the most suitable application for each. Girders, mainly in the form of plate-web girders, were adequate up to spans of around 30m (100 feet), whereas trusses were the more economical and structurally efficient bridge for longer spans.

The longevity of metal bridges is such that a very large proportion of them from the period under review are extant, and most are still in service. Only a few have been demolished. Consequently, there is a large body of hard evidence of our bridge engineering heritage that is, as yet, not under threat. However , the engineering profession and the public should not be complacent because, the demands upon bridges do change, whereby the owners may judge a bridge to be obsolete and only fit to be replaced and removed , usually scrapped.

Bridges, particularly metal bridges, tend to be durable structures. It is often feasible to give them extended lives once the case for their survival has been vindicated. Figure 20 shows an excellent example of a refurbished recycled bridge, and the disused railway lattice bridge at Como has begun a new and less arduous task of carrying a foot/cycleway across the Georges River.

All bridge replacement proposals should take into account the social, environmental and historical factors about the bridge as well as its function and the relevant technical factors. To that extent, this paper should serve a useful purpose.

5 ACKNOWLEDGEMENTS

This paper is the culmination of nearly five years of research. Although a personal project, its success was made possible by the cooperation of a number of people and organisations. In particular, Brian Pearson, Bridge Engineer, and Bob Mayall , Archivist (DMR), Ross Best, Maintenance Engineer for Bridges and Structures, and John Forsyth, Archivist (SRA), and the staffs of the State and Mitchell Libraries, Sydney.

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D. FRASER

Don Fraser is a Senior Lecturer in Structural Engineering at the University of New South Wales. He began his engineering career with the NSWGR in 1949, graduting from the Sydney Technical College in 1954. Following upon 13 years of practical experience in Sydney and London, he joined the University in 1967 and completed his Pd. D. in 1975.

His technical interests are concrete floor systems, buckling of framed columns and the approximate analysis of structures. He also conducts a course in the History of Civil Engineering. In recent years he has become increasingly invoved with engineering heritage and was Chairman of the National Panel for Engineering Heritage during 1983-84. He was awarded the John Monash Medal for 1985 for his paper "Moveable Span Bridges in New South Wales prior to 1915".

Timber Bridges of New South Wales

D.J. FRASER, M.I.E.Aust.*

SUMMARY The construction of timber bridges in New South Wales began in the convict era using the simple timber beam. By the time of the gold rush there was a need for larger bridges which was met by the use of laminated bowstring arches. These were not successful, and so the timber truss was introduced into the Colony around 1860. For the next forty-five years, this form of construction was dominant for road bridges and was used in some locations by the railways. In the early years of federation the new material of reinforced concrete and the greater availability of steel led to a rapid decline in the number of timber bridges built or repaired. The paper traces the history of timber bridges in New South Wales from 1851 to 1905 against the backdrop of contempoary factors such as politics, economic and social demands.

1 INTRODUCTION

New South Wales was known, for many years, as the timber-bridge Colony/State of Australia. By 1900 there were approximately 4,000 timber beam road bridges, 400 timber trusses (mainly as road bridges) and about 20km of timber girder bridges on the steadily expanding railway network. The railway contractors were to eventually build 50km of timber openings (beam/girder bridges) most of which are still in service. There have also been timber arches, and bascule and lift bridges; and timber decks for suspension bridges. There are far more of these timber structures surviving in New South Wales than in any other State, for example, the count of timber trusses (O'Connor 1983) showed NSW 71, Vic 3, Qld 3, Tas 3 and WA 14.

There were two main reasons for the extensive use of timber for bridges in New South Wales, (1) the availability of excellent structural harwoods, particularly from the forests of the North Coast areas. Species such as ironbark, grey gum, grey box, turpentine and tallow-wood were harvested in huge quantities for a wide range of structural uses, such as, buildings, wharves, coal bunkers and rail sleepers, as well as for export. For bridges, ironbark was invariably used.

The second and more compelling reason was that New South Wales could not afford to build costly though durable masonry arches or use expensive imported iron, for all its bridges. Despite the gold rushes of the 1850's, the returns to New South Wales were less than a quarter of Victoria's (Peach 1983) and yet its land area was more than four times that of Victoria. Whereas progress in Victoria was based on much capital created by its local gold production, New South Wales became more dependent on overseas capital to the extent that it imported 50% more than Victoria had to (Fitzpatrick 1969).

Allied to the heavy overseas borrowings and the inflow of investment capital from England, successive Colonial Governments allocated the major share of public works funds to building railways, figure 1. In fact, during the boom years of the 1880's that share peaked at 65%, and yet, there was strong political pressure on the engineers to keep construction costs down. As early as 1861 there was a government decree that local materials (and skills) were to be used as much as possible in order to minimise expensive imports of iron. John Whitton, Engineer-in-Chief 1856-1890, resisted the pressure and built many magnificent masonry arches and iron bridges for the railways, but he was forced to build many bridges in timber.

The Public Works Department, on the other hand, had no choice in the matter. With a meague allocation of 10% for road bridges it is not surprising that they used cheaper timber bridges.

The story of the development of timber bridges in New South Wales and the evidence of the surviving examples is now part of our engineering heritage. Beam bridges, laminated arches and trusses became predominant, therefore, this paper concentrates on their contribution to that heritage.

2 STRENGTHS OF AUSTRALIAN TIMBERS

The abundant local hardwoods had long proved their strength and durability, dating from the convict era, but little was known about their material properties prior to the 1880's. Some proof tests on beams had been carried out on three occassions prior to 1875, however, the information was of little use to later engineers in their desire to refine timber bridge design, particularly for trusses. Data about tensile and compressive strengths, shear and bearing strengths, the influence of grain and the effects of shrinkage was required, for all usable species.

Fortunately, for engineering practice and education in New South Wales, Sydney University appointed W.H. Warren its first Professor of Engineering in 1883 and he immediately set up an extensive programme of tests on all the local hardwoods and some local and imported softwoods (Warren 1886,1890).

The engineering courses presented by Professor Warren and his staff included the latest information on the analysis and design of structures, particularly trusses, and he introduced a great deal of American bridge technology into local engineering through his courses and his many technical papers. He became directly involved in many bridge projects, for both roads and railways, and demonstrated the benefits

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Dr D J Fraser is a Senior Lecturer, School of Civil Engineering, University of New South Wales. (Paper G1169 submitted on 11 April 1985).

that could be obtained from a more scientific and mathematical approach to bridge engineering.

3 BRITISH AND AMERICAN TECHNOLOGY

Bridge engineering in New South Wales from 1850 to 1915 had two eras of dominant technologies, British 1850-90 and American post-1890. New South Wales was a British colony and all its early engineers were educated in Britain and had gained experience there or in Europe. Therefore, when they exercised those skills in New South Wales, the results were direct copies of and adaptions of British/European technology. This situation coincided with the long terms of office of the colony's two senior engineers , John Whitton (railway construction 1856-90) and William C. Bennett (PWD Engineer for roads 1862-89).

Nearly all bridges constructed under their control were of British/European origin. There were some examples of American technology such as the 1880 Whipple trusses at Nowra(Fraser 1981) and the first Hawkesbury River railway bridge of 1889 (King and Fraser 1983) but the intrusion was unwelcomed.

However, the merits of, and in some cases the superiority of, American bridge technology was known to the assistant engineers such as Henry Deane , Percy Allan, E.M.DeBurgh and Harvey Dare; so when Whitton retired and Bennet died in office, an immediate change-over to American style bridges took place, particularly in the adoption of trusses(both in timber and in metal) for large-span bridges.

But the story of timber bridges in New South Wales begins with the simple beam/girder construction.

4 TIMBER BEAM BRIDGES

The longest serving type of timber bridge in New South Wales is the beam or girder bridge. Thousands were constructed, many prior to 1850, and they are still being built in rural areas where secondary and minor roads cross small streams. It is not possible to nominate the first one built nor the oldest extant, but it would have been a road bridge.

The details of construction were rationalised in the 1860's, after the formation of the Public Works Department in 1859, and have changed little since. They consist of parallel girders, Figure 2,at about 1.5m (5 feet) centres for deck widths ranging from 3m (10 feet) to 7.6m (25 feet), the latter including a footway. The inner beams are round timbers with flattened tops, to receive the decking, and the undersides are also flattened at the pier or tressle supports. The outer girders are usually dressed square, hewn in years past but nowadays sawn. The range of spans is 7.6m (25 feet) with single 300 x 300mm girders through to 13.7m (45 feet) in which case doubled or compound girders are used with corbels 2.4m (8 feet) long over the piers. There are two classes of beam bridges for roads, low-level and high-level bridges.

In the former,the deck is constructed about a metre above normal water levels and traffic is often interrupted by freshets. Major floods pass well over the top, maybe 15m (60 feet) or more, and it is intended that the bridge would be available again when the flood recedes. As figure 2 shows, success was not always assured. The high-level bridges are supported on tall piers or tressles such that the decks are supposed to be above the highest flood level. Unfortunately, predicting those levels was and still is fraught with uncertainty and many of these bridges have been washed away also.

Despite the losses and replacement costs, timber beam road bridges could last between 25 and 50 years (Allan 1924) and were very cheap. Based on construction costs in the PWD Annual Reports (1892-1915),and the earlier reports by Martindale (1857-1861), and Bennett (1865,1871), and combined with price indexes supplied by Pope (1984) their indexed unit cost to 1984 is around \$300 per m^2 of completed deck.

Railway timber girder bridges, Figure 3, were similar to the road bridges but the heavier, faster locmotive loading restricted the span to 9m (29 feet 6 inches). The first type was designed by John Whitton in the 1860's and was based on contemporary structures in England (SRA 1847,Haskoll 1867). In addition to that live loading,there was a heavy dead load due to the ballasted track being carried the full length of the structure. Known as the "Whitton type" timber opening, they had the advantage of continuity of track maintenance but the difficulties of replacing wet and rotting deck planks and girders. Based on the cost of the timber viaducts at Wagga Wagga (completed in 1879 but replaced in steel in 1896-1901), the 1984 indexed cost is about \$500 per m^2.

After Whitton retired, Henry Deane continued the railway construction programme during the 1892-97 economic depression. Construction of the expensive main trunk lines through the Great Dividing Range had been completed, figure 4, and extending the network to service the flat farming country was commenced. Deane introduced a new form of low-cost construction,based on the developmental railways of America, called Pioneer Lines (Deane 1900). One of the cost-cutting measures was the redesign of the timber opening , whereby the ballast was eliminated and the rails carried by transoms (large bridge sleepers) directly on the girders. Reduction of the dead load, the use of lighter locomotives and a span limit of 7.3m (24 feet) enabled three rather than four sets of girders to be used. This form of construction constitutes most of the 50km of timber railway openings in use today. Deane did not record the unit cost of these cheaper structures but the savings can be gauged from the fact that the overall cost per mile (or km) was half that had construction been to the previous "Whitton"standard. Therefore, the indexed cost of the transom-top timber railway bridge appears to be approximately the same as the timber beam road bridge.

With spans limited to the range 9m to 13m for any form of timber girder construction, a different structural system was required for the hundreds of larger spans for crossing the gorges of the mountain streams, and the main channels of the major coastal and inland rivers. Apart from some imported wrought iron plate-web girders and lattice bridges of spans up to 60.5m (198 feet), the increase in span was achieved using laminated arches and then trusses.

5 LAMINATED ARCHES

Four laminated bowstring arches, figure 5, were constructed for road traffic in the 1850's under the direction of Colonial Architects Edmund Blacket and William Weaver. For the 1855 Denison Bridge over the Macquarie River at Bathurst there were five spans, three at 27m (90 feet) plus a shorter span at each end, so the larger arches doubled the maximum span of the beam bridges. There were three arches per span made from local blackbutt. Including the tressles, a total of 100,000 feet of this timber was used. The iron rods and other iron work was supplied by the Government Foundary at Glebe, Sydney. The bridge was built by day labour under the direction of Mr. Downey who had also built the earlier arch bridges at Yass and Maitland. The overall length was 116m (380 feet), the overall width was 10m (33 feet), the height above

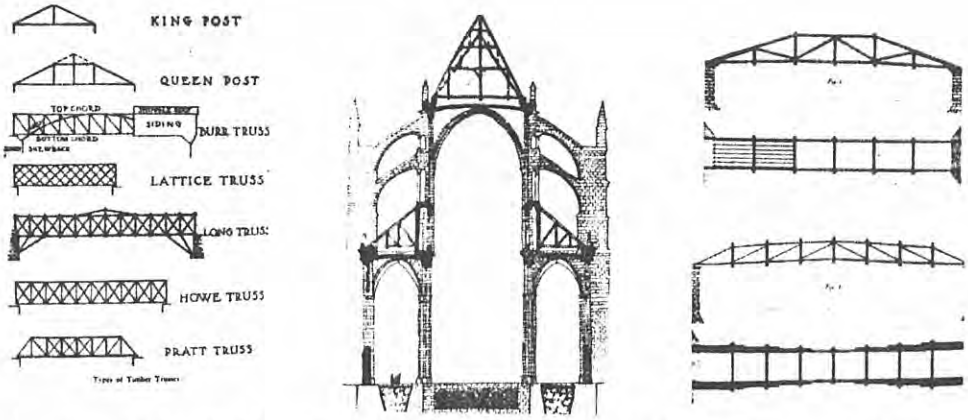


Figure 6 Five American timber bridges (left). The Howe became the Allan truss and the Pratt became the DeBurgh truss. But Medieval roof trusses and Palladio's bridges were in use centuries before.

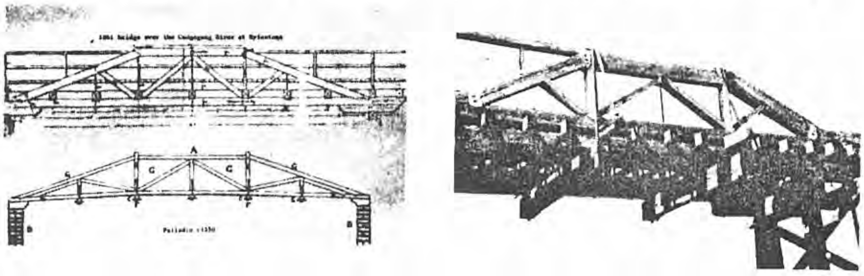
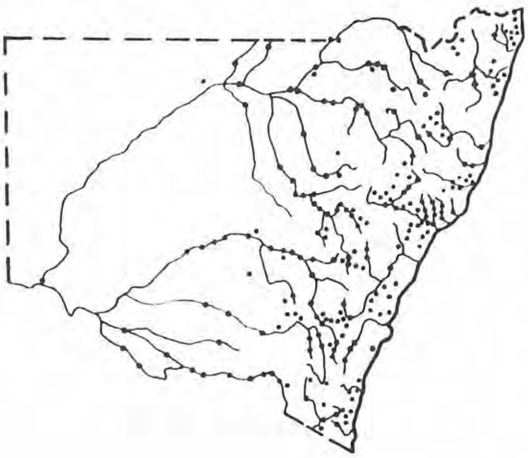


Figure 7 The first timber trusses, both for road and rail, were modelled on one of Palladio's trusses. A survivor of that style spans Umeralla Creek on the Cooma Line.



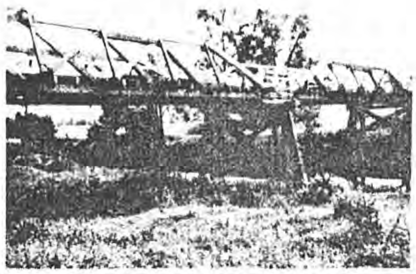


Figure 8 In fifty years, 1865-1915, the timber truss became the dominant road bridge for spans exceeding 15m (50 feet). More than 350 were built at about 250 sites (left) in New South Wales. An example of the OLD PWD design exists over the Karuah River at Monkerai, 1877.

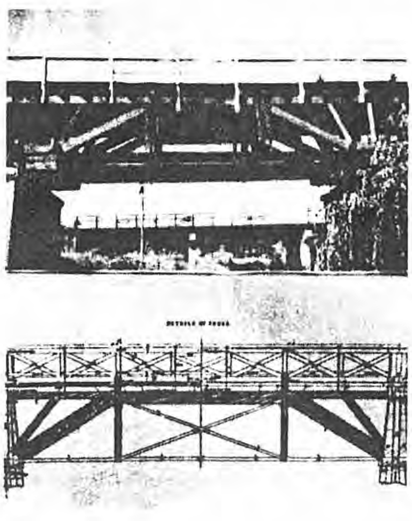


Figure 9 John Whitton used British technology at every oppotunity, even when compelled to use timber trusses. Six sets of these Queen Post trusses, modelled on Brunel's bridges in Devon and Cornwall, were built in New South Wales during 1885-89. All are still in service.

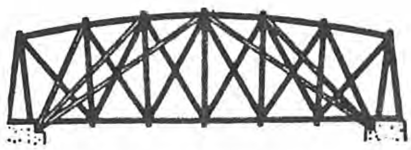


Figure 10 The McCallum truss was popular in America but only two sets were built in New South Wales, at Cowra in 1870 and at Casino in 1874. The untidy arrangement made construction difficult and maintenance was not an easy task.

water was 7m (23 feet) and the whole work cost £11,074 (Martindale 1857), which represents an indexed cost $630 per m².

But the fabrication of the arches was difficult, 50 mm (2 inch) planks had to be steamed, bent and fastened together, and when water later penetrated the interfaces causing wet rot of the laminates,it was impossible to replace them. Also, the shrinkage of Australian hardwoods generated gross distortions, particularly twisting, which caused essential tension rods to break. Despite the initial jubilation about these timber arches, their faults were all too obvious to Commissioner Bennett. Consequently, only three more of these bowstring arches and two spandrel arches were built between 1861 and 1882 by this government agency, for road bridges.

There was however, a laminated spandrel arch built privately in the 1860's over the Murray River linking Wahgunyah and Corowa. In 1839 John Foord and John Crisp established the Wahgunyah run which extended across the river (Victoria was not a separate colony at the time) and the private township of North Wahgunyah was laid out in 1856, subsequently proclaimed Corowa in 1859. When the river boats began bringing supplies for the gold fields at Rutherglen and Beechworth, the town became an important landing place. It also became an important crossing point for stock. There was a need for a bridge.

But the Sydney-based Government was not in a position to finance a bridge so far away in the Riverina so John Foord formed the Wahgunyah Murray Bridge Co. and a three-span timber arch bridges was built for £10,000 and opned in September 1862. The company was allowed to charge tolls. In 1877 the colonial governments were offered to buy the bridge, Victoria agreed but New South Wales refused. Eventually, in 1883, the latter bought the bridge and after it was found to be in a dangerous condition, was replaced by the present iron lattice bridge in 1895.

In his 1865 Report, Bennett listed the costs of the five laminated timber arch bridges built in the previous decade. The average unit cost, indexed to 1984, is $1,000 per m², which shows that they were costly bridges and, as their short lives proved, they were not very cost-effective.

Although receiving large funds for railway construction, John Whitton was forced to use timber arches. Bowstring arches, similar to those constructed on the Kent Railway in 1847 and to those just described, were built over the four streets west of Parramatta railway station, figure 5.

For crossing the Hunter River at Singleton, Whitton was denied funds for an iron bridge, "the House refused to vote money for it until I had laid the plans on the table to show that I intended to use timber not iron". Whitton designed 5/24.4m (80 feet) laminated timber arches of the spandrel type, figure 5, which took four years to build. Completed in 1866 at a cost of £51,300, they were wide enough to take road and rail traffic for the whole of the service life. The indexed unit cost was an exhorbitant $3,700 per m². When combined with the maintenance difficulties and had to be completely replaced in 1902 by steel trusses, the Colony could hardly claim to have got value for its money.

The Cooma Line, constructed during 1884-89, had all its major bridges made from timber, including two sets of laminated timber arches over the Molonglo and Queanbeyan Rivers. These were a resurrection of the Singleton bridge and it must have pained Whitton to be forced to use an unsatisfactory structure. They were no more successful than the Singleton arch and were replaced by steel trusses in 1926.

6 THE TIMBER TRUSS BRIDGE

6.1 Its origins

Despite the development of the truss bridge in America during the nineteenth century, figure 6, and their extensive use in that country, the truss was not an American invention. It had been used in Britain and Europe since Medieval times mainly for roof trusses of Gothic Cathederals, figure 6, and for stately homes and palaces. Around 1550, Palladio had demonstrated the concept of a timber truss bridge, figure 6, but due to the demands of ship builders, the iron industry using charcoal, and of domestic heating, timber was generally too scarce for bridges. Although Britain and Europe relied more on masonry arches and iron bridges, some significant permanent timber bridges were built and timber was used for tempoary bridges, for example, to minimise the initial costs of railways (SRA Archives 1847).

In America, these restrictions were small and the availability of timber was almost infinite, consequently, timber trusses were the principal form of American bridge construction for the first seventy years of the nineteenth century.

So many bridges were required in America that bridge building became a profitable and highly competitive industry. There were many types of bridges patented of which figure 6 shows a sample. Designers and builders hawked their bridges around the country like any commercial product with catalogues, sales talk and guarantees. Ethiel Town extolled the flexibility of application of his lattice bridge by claiming to "build it by the mile and cut it off by the foot".

There were about twenty viable designs for timber truss bridges but eventually only two showed all-round suitability, the Howe and the Pratt trusses. These became the principal types in New South Wales after 1892, the Howe for timber bridges and the Pratt for steel bridges and for some composite trusses.

Prior to this "Amaericanisation" of colonial bridge engineering , the accumulated evidence points to a British colony adopting and adapting British/European technology. The new trusses of the 1860's, figure 7, were clearly derived from Palladio's ideas through William C. Bennett's earlier work with the Colonial Architects Office. That office was in charge of bridge design and construction until the Public Works Department was formed in 1859. Bennett makes it clear that American technology had not yet arrived when he said in his 1865 Report, "for spans exceeding 100 feet (30m), a design on the principal of the McCallum truss, so extensively used with the softer and lighter timber in the United States, has been under consideration for some time and will be applied when the opportunity offers" (Bennett 1865).

6.2 The Queen truss

The ex-Palladio truss, called a Queen truss by Bennett because of its adaption from the Queen Post roof truss and later referred to as the OLD PWD design, was suitable for spans around 15m (50 feet). For longer spans, up to to 27m (90 feet), Bennett added an inner Queen truss, figure 8, and referred to it as a compound Queen truss. More than a hundred of these bridges were built in the twenty years 1865-1885, but only two survive, over the Karuah River at Monkerai, figure 8, dating from 1877, and over the Williams River at Clarencetown (originally 1878 but completely rebuilt in the old style in 1926/27).

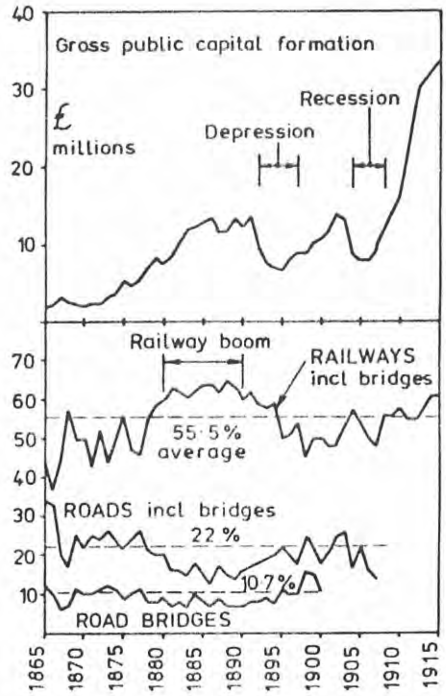
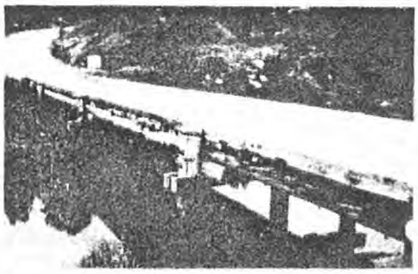
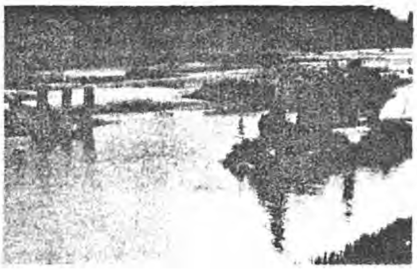
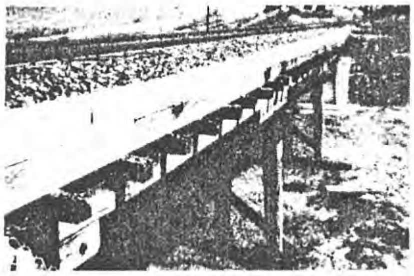


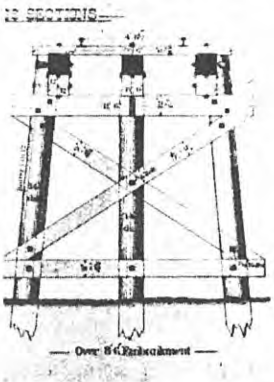
Figure 1 Funds for public works and their allocation to railway and road works 1865-1915. (Butlin 1962).

Figure 2 A typical timber beam road bridge (right). These cheap, simple structures have served New South Wales well, but they have limited spans and are easily damaged by floods.









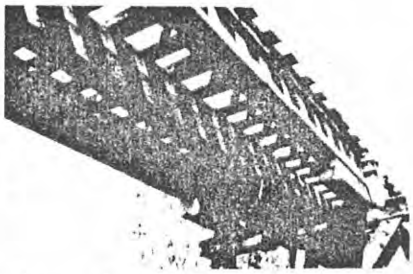
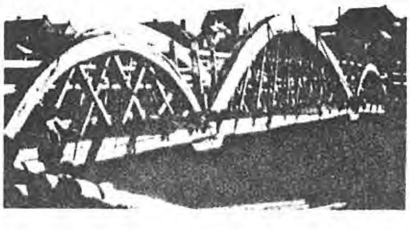
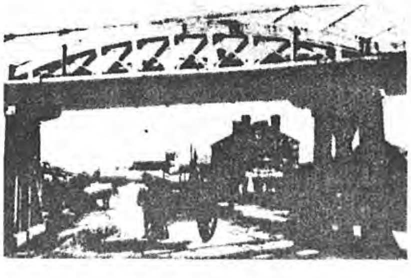


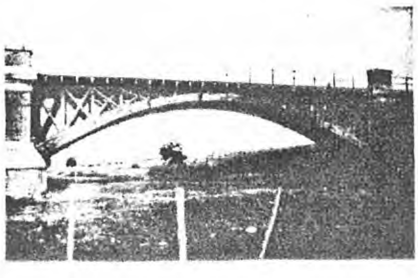
Figure 3 The railways built thousands of timber girder bridges, with a total length of 50km. The "Whitton" type (top) carried ballasted track. After 1890, transoms supported the rails so only three girders were required.

Figure 4 By the 1890's Whitton had constructed the three trunk routes (top) to Albury, Bourke and Wallangarra. Henry Deane's task was to build the branch lines.

Figure 5 The laminated arch was the first large-span bridge and those over South Creek, Windsor (left) of 1853 are typical. The railways used the same style at Parramatta as well as spandrel arches at Singleton and on the Cooma Line.







In his 1865 Report, Bennett lists the sizes and costs of these new timber truss bridges. They have a 1984 indexed cost of $500 per m², half that of laminated arches and one third the cost of an iron bridge. With this cost advantage, the timber truss in its various styles became widely used throughout New South Wales for road bridges for the next fifty years, figure 8.

Despite the "mountain" of money for railway construction, John Whitton was forced to reduce the standards of construction, including bridges. He was using iron lattice girders for major river crossings (Best and Fraser 1982), but had to substitute timber structures, arches and trusses, at many locations. A set of ex-Palladio trusses had been constructed over the Fish River at Gunning in 1875 for the Great Southern Railway but Whitton had successfully resisted their wider use for another eleven years, when, in 1884 three more sets were built, over the Bogan River at Nyngan, the Cudgegong River near Rylestone on the Mudgee Line, and a little later over Umeralla Creek on the Cooma Line, figure 7.

These early railway timber trusses were in service for between 40 and 50 years, which suggests that contrary to Whitton's strong opposition to timber bridges, they were reasonably cost-effective. But it should be noted that they soon became inadequate for the increasing weight and speed of locomotives, thereby requiring speed restrictions, which in turn reduced the efficient opration of the rail traffic. The Umeralla Creek bridge is causing these problems today and is soon to be replaced.

A far more successful and durable set of railway trusses, figure 9, were built in the latter part of the Railway Boom 1886-1889. The design was adapted directly from British railway practice (Haskoll 1867 and Mahan 1847). Four sets of these deck Queen Post trusses were built between Glen Innes and Wallangarra, and two sets on the Cooma Line south of Michelago, and all are still in service.

The OLD PWD timber truss became the standard design for road bridges. But there were two attempts in the early 1870's to use American technology to extend the span of timber trusses beyond 30m (100 feet). McCallum trusses, figure 10, of 40m (130 feet) span were used to cross the Lachlan River at Cowra in 1870, and the Richmond River at Casino in 1874. They may have been an experiment to test the viability of American bridge-engineering methods under Australian conditions, maybe the "messy" crossing of sloping timbers at the ends of each span complicated the construction, whatever the reasons, the switch to American trusses did not take place until the 1890's.

6.3 The McDonald truss

The next change took place in 1886 with a modified design of the OLD PWD trusses due to the interaction the following social and technical factors; a steady increase in rural settlements and the amount of farming (wheat acreages doubled each ten years), the boom of the 1880's and the improved conditions of roads and bridges. These factors led to a greater frequency of traffic and the use of heavier vehicles, for example, 16-ton traction engines, figure 11, with 10-ton trailing carts, compared with 6-ton drays. This amounted to a trebling of the previous design loads, hence the need for stronger bridges.

The first of these was introduced by J.A. McDonald for spans 20m (65 feet) to 27m (90 feet) and has become known as the McDonald Type Truss, figure 11. The principal improvements to the OLD PWD design were the use of combinations of smaller sizes of timbers, and the inclusion of steel wedges, figure 11, at the bottom chord joints in order to "tighten-up" the bridge as shrinkage occurred. McDonald also devised methods for renewing any part of the truss which simplified maintenance and reduced the annual repair bills. The indexed construction cost of the McDonald trusses is in the order of $1,000 per m² of deck which, although double the cost of an OLD PWD bridge, was consistent with the increased quantity of material used in order to support the heavier loads. Therefore, in terms of the increased load capacity, this new design was still cost-effective.

At the beginning of 1984 there were thirteen McDonald trusses remaining in New South Wales, all dating from 1887 to 1893. Some notable examples are located, in Galston Gorge near Hornsby, over Cox's River near Lithgow (McKane's Bridge), over the Bega River near Bega (Tarraganda Bridge) and three near Bombala.

But J.A.McDonald did more than improve an earlier design, he introduced a new concept, the composite truss, which almost doubled the span of timber bridges. He recognised that timber was best suited to compression members and that iron/steel was best in tension, so when the McCallum trusses at Cowra were due for replacement around 1890, McDonald proposed three 49m (160 feet) trusses in which the bottom chords were made from steel channel sections. These trusses, figure 11, were constructed in 1893 and after ninety years service are being replaced.

Composite construction had many advantages over the all-timber truss but it took another ten years before McDonald's innovations were incorpoated into standard designs by E.M. DeBurgh and Harvey Dare. In the meantime significant improvements were made in the design construction and maintenance by Percy Allan.

6.4 Allan trusses

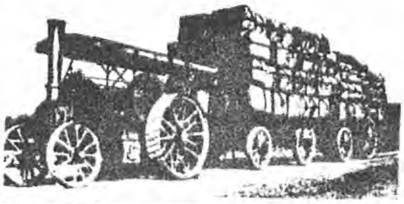
The most common surviving timber truss road bridge is the Allan truss, named after its designer, Percy Allan, the Colony's leading bridge engineer, figure 12. He is synonymous with timber-bridge engineering for three reasons, (1) in 1893 he introduced the refinements and structural efficiencies of American truss technology to New South Wales, (2) he combined the improved methods of structural analysis and design with the results from Professor Warren's tests (see earlier) to (3) produce a well-engineered bridge that proved to be durable and very economical. This last point can be demonstrated from the costs of bridges noted in the Annual Reports of the Public Works Department. The indexed cost of the pony or half-through Allan truss averaged around $700 per m² because it used less material and was easier to build. But it was stronger, wider and easier to maintain than the previous trusses.

The Allan trusses was 40% dearer than the OLD PWD design but was an infintely better structure. This cost-effectiveness was a perfect foil for the severe economic downturn of the 1890's and helps explain why so many timber bridges were built in the depression decade of 1891-1900. The reduced cost of bridge construction complemented ideally the government policy of easing unemployment through public works.

The improvements introduced by Allan were,

1. all diagonals and the sloping end members were of spaced construction which greatly increased their buckling strengths for a modest increase in construction costs.

2. the top chord was opened out to form a spaced



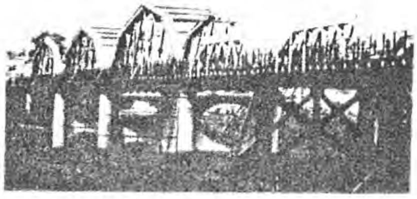


Figure 11 J.A. McDonald redesigned the OLD PWD truss to carry much heavier loads (top left) and the new truss (left) bears his name. An important feature was the inclusion of opposing steel wedges (above) to "tighten-up" the bridge. His largest project was the 1893 Cowra Bridge (right) for which he designed three 49m (160 feet) composite overhead-braced trusses.

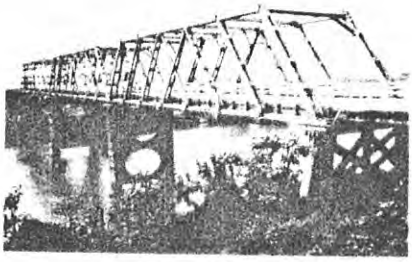
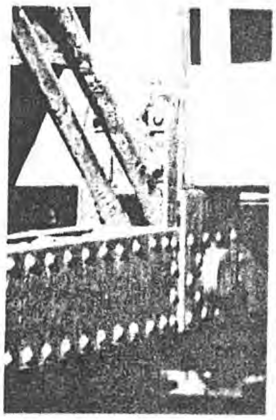
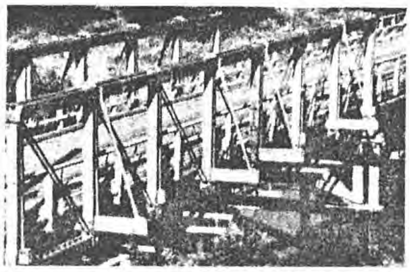


Figure 12 Percy Allan (1861-1930), "Mr Timber Truss Bridge", is synonymous with timber construction. He joined the Public Works Department in 1878 and became a competent and innovative bridge designer. Probably his best known bridges are the electrically operated swing spans at Pyrmont and Glebe Island. His 1894 designs of the pony truss (above) and overhead-braced trusses (right) bear his name.





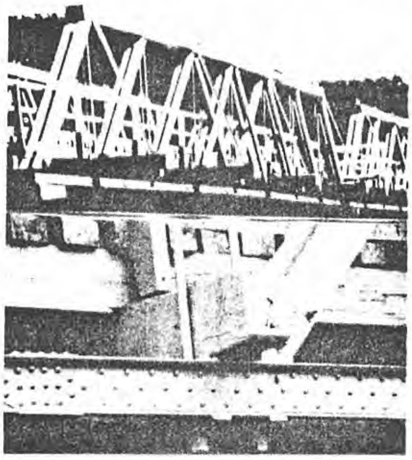
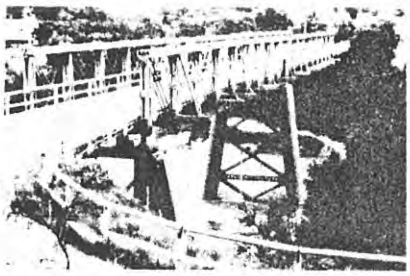
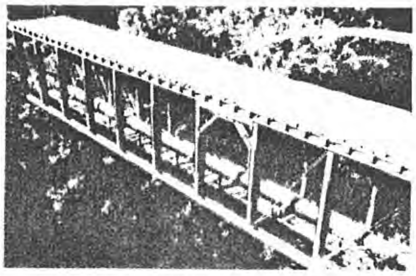
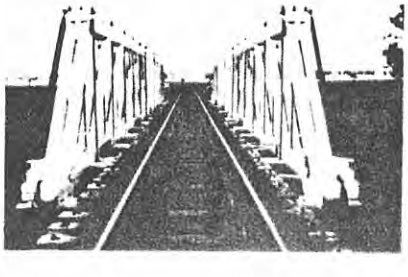


Figure 13 E.M. DeBurgh designed a composite Pratt truss in 1899 (left). It has a steel bottom chord with pin joints, and metal diagonals. Harvey Dare redesigned the Allan truss in 1903 for composite construction (right) and simplified some of DeBurgh's details.

Figure 14 Two of DeBurgh's major bridges. The two-span pony trusses over the MacDonald River at St. Albans, and the deck truss over the Lane Cove River known as the DeBurgh Bridge. There are plans to preserve this historic bridge.







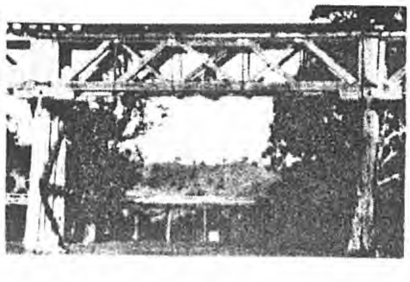


Figure 15 Road bridge designers of the Public Works Department also designed railway bridges as the 1908 pony truss shows. Deck trusses were more common for railways and the viaduct (right) at Gundagai has 78 of them, each of about 11m span. The viaduct was completed in 1903.

column over the mid-span region which increased the lateral stability.

3. the bottom chord, although in tension, was also of spaced construction, but this time the purpose was to allow water to pass through and not collect in the joints.

4. all joints and the surfaces of members were accessible for inspection and maintenance.

5. external iron clamps at joints meant there was negligible drilling of timbers for the large-diameter suspension rods.

6. cast-iron shoes at all joints allowed simpler shaping at the ends of timbers and ensured a better distribution of forces through structurally sound joints.

7. well-designed splices (a direct result of Prof. Warren's timber tests) enabled shorter pieces of timber to be used. Large, long timbers of the OLD PWD and McDonald designs were becoming more difficult to obtain and were difficult to install during repairs.

8. any member could be renewed without temporary staging from below and without taking the bridge out of service.

9. the regular simple panels made it easier to tighten-up the bridge to counteract the long-term deflections due to shrinkage and creep. However, this was not always successful, so that in recent years many timber trusses have under-slung cables to control deflections and add strength.

The key to the success of the Allan truss was the relatively simple device of building two half-trusses and bolting them together. It was easier and cheaper to construct the trusses from smaller pieces of timber and, during any subsequent repairs, the replacement of half-members was not only a simple procedure but the bridge could, with some restrictions, still carry traffic.

Some excellent examples of Allan's timber pony trusses, still in use after ninety years of service, are at Tharwa in the Australian Capital Territory over the Murrumbidgee River, at Picton over Stonequarry Creek, over the Turon River near Sofala and the Paterson River at Vacy.

Equally good examples of overhead-braced timber trusses are the bridges at Morpeth over the Hunter River, the nearby Dunmore Bridge over the Paterson River and the Hampden Bridge over the Murrumbidgee River at Wagga Wagga.

The age of these examples and of the surviving Allan trusses underlines their durability and, because of the modest maintenance costs, the long-term economics of his designs. Traffic conditions and road improvements will mean replacing some of these but there are about fifty that are adequate and so will remain in use for many more years to come.

6.5 Composite trusses

The Allan trusses were modelled on the successful American Howe truss with the compression top chords and the diagonals in timber, and iron rods for the vertical tension members. For structural consistency the bottom tension member should also have been made from iron or steel. But Percy Allan persisted with a timber bottom chord because he strongly believed that a well-designed timber bridge, with good joint details and a suitable arrangement of the timbers, was more than competitive with metal structures. However, the merits of composite construction were not lost on Allan's successors, E.M. DeBurgh and Harvey Dare. Two types of composite trusses were developed, the Pratt by DeBurgh in 1899, and the Howe type by Dare in 1903, figure 13.

The most impressive examples of extant composite trusses are all DeBurgh/Pratt trusses which helps explain why DeBurgh's name is perpetuated whereas Dare's contributions to local bridge engineering are all but forgotten.

The bridge over the Clarence River at Tabulum has five DeBurgh trusses each of a nominal 32m (106 feet) span. At St. Albans over the MacDonald River there are two 36m (118 feet) trusses, figure 14, the largest spans without overhead bracing. DeBurgh's crowning achievement was the 50m (165 feet) deck truss , figure 14, that carried Ryde Road over the Lane Cove River from 1901 to 1967. This bridge is the only deck Pratt truss in New South Wales and is the largest timber span in Australia. Its future is in doubt because it is no longer required, even to carry water mains. But action is being taken through the National Trust to preserve this historic structure.

DeBurgh's designs included improvements consistent with the Pratt system plus all the good features of the 1893 Allan truss,

1. a permanent bottom chord in steel, a fabricated section in the end panels but for most of the span, consisting of two steel flats.

2. spaced timber top chords for greater stability and shedding of water.

3. top chord splices so that shorter, more readily available timbers could be used. New South Wales was exporting a lot of the best quality ironbark which restricted supply for structural uses.

4. custom-designed metal shoes for good jointing of timber and metal members.

5. well-detailed joints for proper structural action

6. accessible ends of tension rods for ease of tightening-up the bridge.

7. the number of diagonal rods was varied to suit the changing shear force across each panel.

8. the sizes of the compression verticals was also varied to suit the shear force, and spaced construction was used to increase stability. In the St. Albans bridge there are four vertical pieces spaced to form a square and bowed to give greater stiffness at mid-height.

9. simple pinned joints in the bottom chord to ensure proper joint action combined with easy connections to the diagonal rods and timber verticals.

10. duplicate members for easy renewals plus an easy slide-out-slide-in arrangement for replacing cross-girders. This could be achieved without underpinning or taking the bridge out of service.

The composite Pratt/DeBurgh truss may well have been the best form of construction for the large spans for which it was used, but the majority of bridge sites were suitable for shorter spans and the Allan or Howe truss was usually adequate. Recognising the advantages of composite construction, Harvey Dare redesigned Allan's 1893 truss in order to incorporate a steel bottom chord and to simplify the bottom chord joints, figure 13, by eliminating the pin as used in the DeBurgh truss.

Fabrication of the bottom chord was simplified by using rolled steel channels spaced back-to-back with the vertical rods passing through the gap to simple bridging plates on the underside of the channels. The timber cross-girder was positioned between the vertical rods which alowed slide-out-slide-in replacement as in DeBurgh's design.

The overall effect of Dare's improvements was that no more DeBurgh trusses were built, and of the limited numbers of timber truss road bridges built between 1905 and 1935 , nearly all were of this composite design.

6.6 Railway timber truss c1900

By 1892 the trunk-line network had been established. All that remained was to fill in between with branch/feeder lines, build the easier route to Brisbane via the North Coast and complete the Sydney suburban lines. Nearly all the branch lines were located on the flat open country west of the Great Dividing Range in the wheat belt (just as in mid-west U.S.A.). Freight traffic was highly seasonal and did not justify expensive capital works lying virtuallyunused for most of the year. Therefore, Commissioner Eddy and Henry Deane (Whitton's successor) advocated and successive Governments approved, the American practice of construction cheap developmental lines, known locally as Pioneer Lines.

Despite the policy of no significant bridges on these lines, important rivers still had to be crossed, the Namoi, Talbragar and Cudgegong just to mention a few. The cheapest form of crossing would have been timber beam viaducts but the large volumes of flood water and tons of debris carried by the inland rivers ruled out this option, at least over the main channels. In order to achieve reasonable waterways for the main channels, the design engineers adapted the successful timber truss road bridge to railway needs. The first of these was built across the Namoi River in 1897 (now replaced) for the line to Moree. These trusses were Howe trusses of the pony or half-through type, figure 15, just like their counterparts on the road system. But deck trusses were also designed and constructed, the most impressive example being the long viaduct across the Murrumbidgee River at Gundagai completed in 1903, figure 15. Of the many railway timber trusses built in the succeeding twenty years, eleven are extant and ten are still in service.

7 DEMISE OF THE TIMBER TRUSS BRIDGE

World War I (1914-18) acted somewhat as a technical watershed for bridge engineering in New South Wales. Prior to the War, the timber truss had been the dominant form of construction for major road bridges. After the War, steel trusses were used for all major crossings involving spans in excess of 30m (100 feet). For medium spans, around 20m (60 feet) steel beams or girders were used. For spans less than 13m (40 feet) the timber beam bridge was still suitable but was being replaced wherever possible by the new technology of reinforced concrete(Fraser 1985).

The trend towards this situation had begun well before the War. For example, railway administrators had adopted a policy, during the 1890's, that as timber bridges deteriorated, their replacements would be in steel and/or concrete. All new major bridges, such as those on the North Coast Railway, were either steel trusses or plate-web girders. The approach viaduct were often timber beam spans. By the beginning of the War, there had been a ten-fold reduction in the number of timber truss bridges constructed in New South Wales.

There were many factors leading to the demise of the timber truss, the most significant of which (not in order of importance) were,

1. in the 1896 Annual Report of the Public Works Department, comment was made on the difficulties of obtaining suitable timber, and in 1908 the Report stated that such difficulties were causing delays in constructions.

2. the availability of skilled bridge carpenters had declined by the turn of the century and, combined with a steady increase in the cost of labour, the cost of labour-intensive maintenance of timber bridges became too high.

3. better roads and bridges, and flatter gradients, had led to the use of heavier vehicles so that much stronger bridges were required.

4. half-through construction was inherently weak in lateral stability of the top chord, even though Allan's details and the use of external rakers had helped. Adding some form of overhead bracing was a temporary solution.

5. at 50m, the composite truss had extended the economical range of timber construction to its limits. For longer spans and heavier loads , steel trusses were the answer.

6. the new material of reinforced concrete was proving to be both economical and durable, initially in the form of arches, then as slab bridges and by 1916 in the now familiar form of beam and slab construction.

8 CONCLUSION

The timber truss bridge in New South Wales was introduced, developed and refined over a 52-year period, from 1861 with the "Palladio" truss, to 1903 with the composite Howe truss. There was a brief trial with laminated arches and virtually a continuous use of timber girder bridges. The history of the technical changes can be traced against the background of concurrent social, political and economical factors. The most significant of these and of the technical changes have been described in this historical review.

Over 400 timber trusses, 12 laminated arches and about 100km of timber beam bridges were constructed prior to 1915, considerably more than in any other part of Australia. New South Wales became known as "the timber-bridge Colony/State of Australia".

This paper has sought to explain why the history of these bridges and their surviving examples, particularly the trusses, are an important part of our engineering heritage.

9 ACKNOWLEDGEMENTS

Most timber bridges in New South Wales were built by successive Government Agencies responsible for roads and railways. A large amount of archival material is presently held by the current responsible organisations, the Department of Main Roads and the State Rail Authority. The author gratefully acknowledges the research assistance from officers of both instrumentalities, particularly Brian Pearson and Bob Mayall (DMR), and Ross Best and John Forsyth (SRA). A great deal of useful information was also obtained from the Sate and Mitchell Libraries, and the assistance received from their staffs is greatly appreciated.

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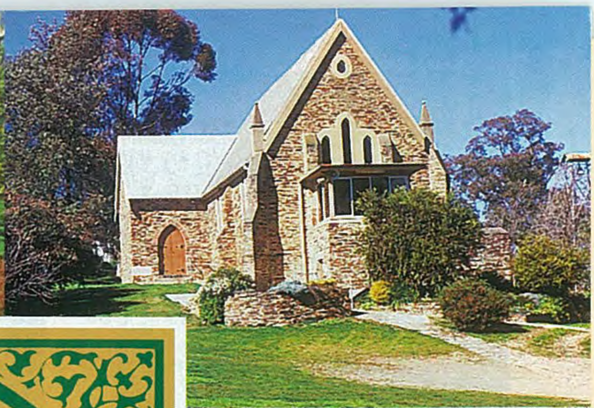
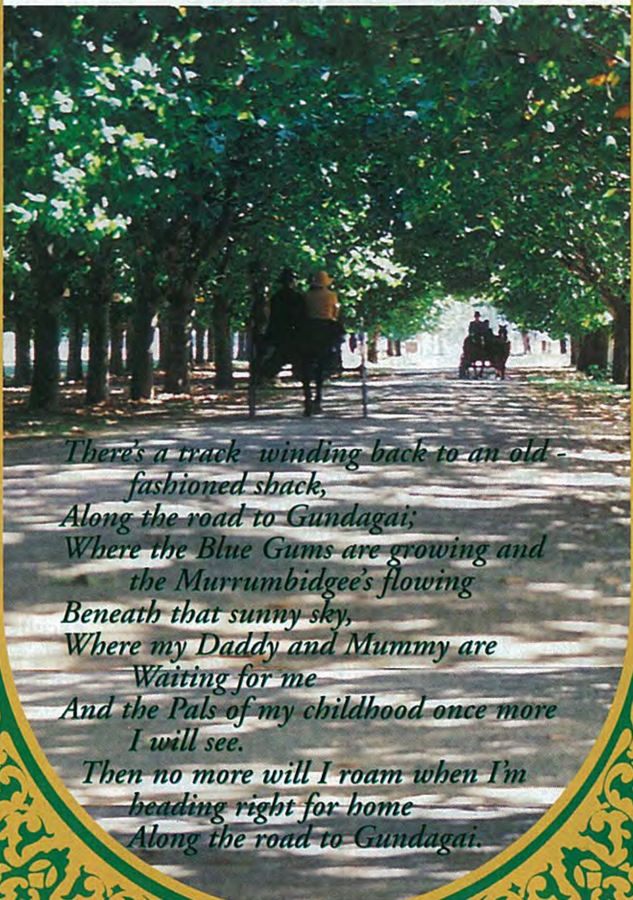
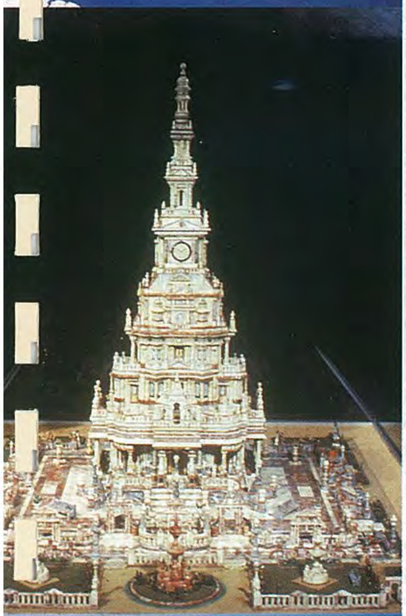
For photo and biographical details, see page 81

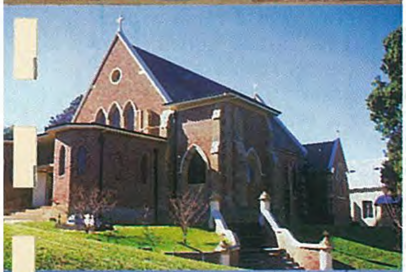


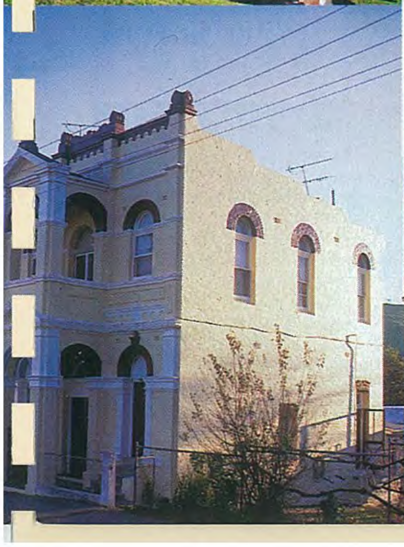
Discover Historic Gundagai

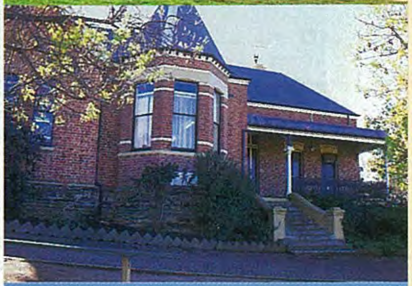
NSW

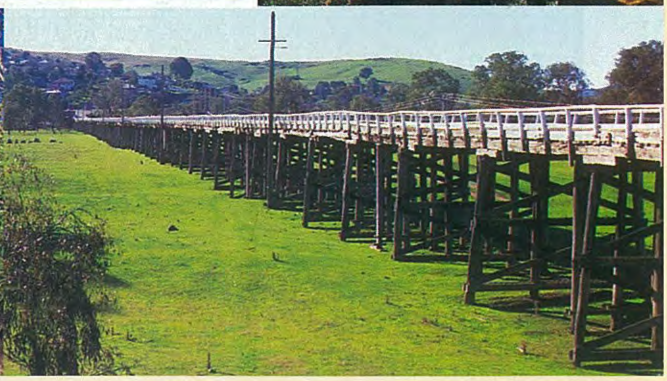












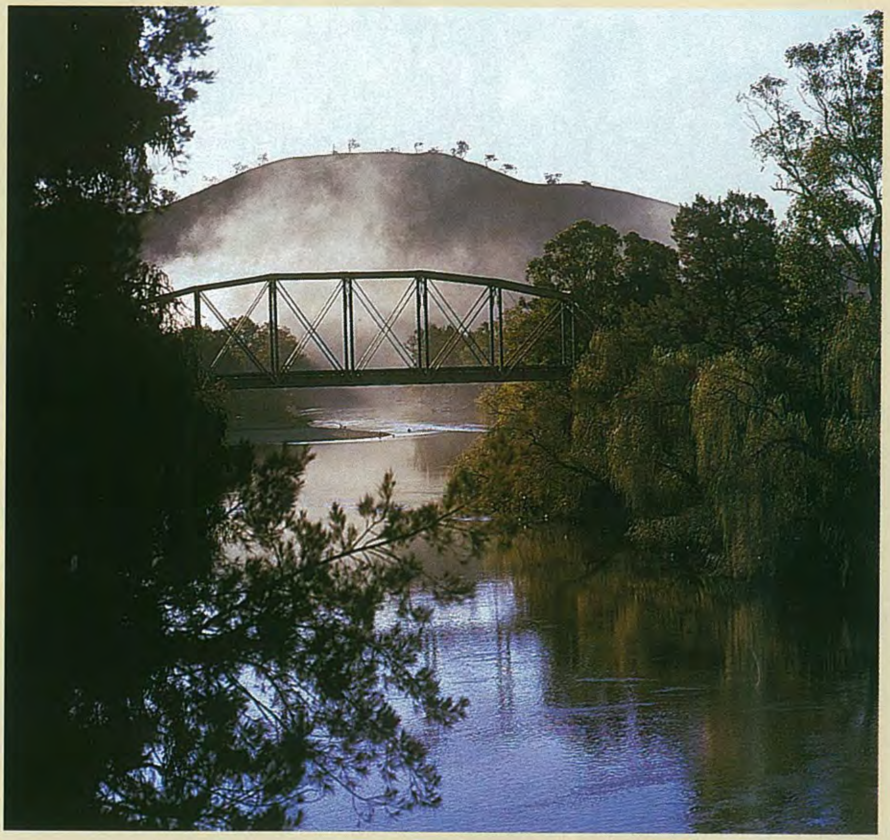
STEEPED IN HISTORY

Situated on the banks of the Murrumbidgee River and nestling at the foot of Mount Parnassus in the beautiful Murrumbidgee Valley, the famous town of Gundagai is steeped in history and wonderful heritage attractions.

Long a favourite stopping place for travellers along the Hume Highway, historic Gundagai is a fascinating place to visit and learn about many of the uniquely Australian events, characters and buildings which have etched a special place in the folklore of this country.

It was in 1824 that the overland explorers Hamilton Hume and William Hovell, and then the rivermen Charles Sturt and Thomas Mitchell, opened up the trail for land-seekers and pioneers.

Five Mile Creek, a few kilometres north of Gundagai, became a popular camping spot for teamsters and their lumbering, supply-laden bullock wagons. Today it's the site of that famous Australian icon, the Dog on the Tuckerbox, along with 'Snake Gully' where four legendary folk characters, Dad and Dave, Mum and Mabel, are enshrined in copper.



Early morning on the Murrumbidgee River at Gundagai.

The greatest natural disaster Australia has yet experienced was the great flood of 1852 when the Murrumbidgee River swept away the original town and 83 inhabitants perished beneath those murky waters.

Gundagai is rich in its association with colonial days. Woven into its historical tapestry are legends of the prospectors, and of bushrangers Ben Hall and Captain Moonlite, drawn by the lure of the gold the miners won from the reluctant earth. Reminders of the gold fever which gripped the town and the district in 1861, and again in 1894, may been seen in the abandoned buildings and gold mines not far from the town.

Many of its magnificent heritage-protected buildings, such as churches and the outstanding court house, (scene of many historical court cases, including the trial of the bushranger Moonlite), date back well over 130 years.

Gundagai today is a sympathetic blending of fine historic architecture and modern commercial and residential development. Gundagai's expanse of fertile river flats remains to this day, with the central shopping precinct surrounded by a patchwork of farm pastures and crops, constant reminders of Gundagai's important role as a service centre for a widely recognised, rich, agricultural industry.

With its charming restaurants, and excellent accommodation to suit all budgets, Gundagai offers a tranquil yet fascinating break for the holiday-maker.

Gundagai, 225m above sea level, is 370 kms by road from Sydney, and 493 kms by road from Melbourne. Nearest towns are Tumut (35 kms), Adelong (35 kms), Batlow (66 kms) Cootamundra (59 kms), Junee (62 kms) and Wagga Wagga (84 kms).

CONTENTS

GUNDAGAI: SO MUCH TO SEE AND DO

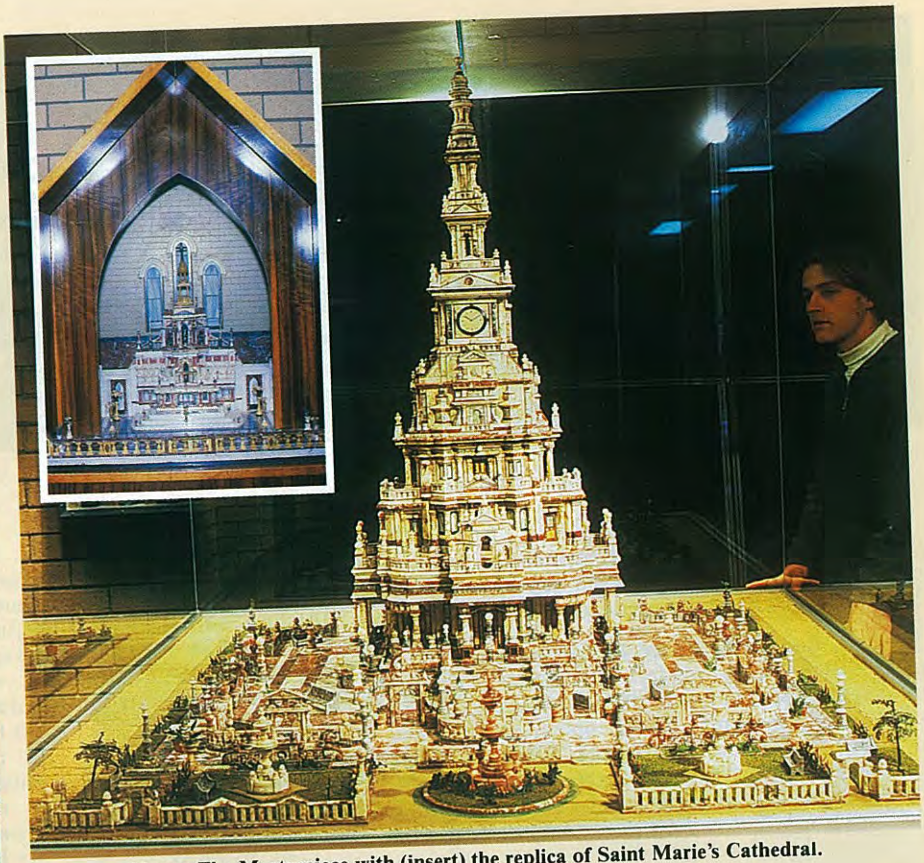
Dog on The Tuckerbox

The famous Dog on the Tuckerbox is located, as the song relates, five miles (or 8 kms) north of Gundagai, just off the Hume Highway, where it guards a restaurant and souvenir and gift shop at Five Mile Creek.

The monument gives expression to probably the best-known slice of Australian folklore — mateship between man and dog. In the pioneering days a dog accompanied each wagon and, besides being a faithful friend of the teamster, guarded his master's possessions. A verse about a dog sitting on a tuckerbox was written by an unknown teamster some 100 years ago, but the well-known poem was written by poet and traveller Jack Moses.

The restaurant and gift shop complex behind the monument is set among native trees and shrubs and next to an attractive fernhouse. Nearby are the ruins of the ol' Five Mile pub, the remains of the hotel where camping teamsters gathered to drink and diggers slaked their thirst before moving on to the next gold strike.

Gundagai has long been immortalised through such poems and songs as 'The Dog on the Tuckerbox', 'Along the Road to Gundagai', 'My Mabel Waits for Me' and 'When a Boy from Alabama Meets a Girl from Gundagai'.



Above: The Masterpiece with (insert) the replica of Saint Marie's Cathedral.

Rusconi's Marble Masterpiece

The famous dog on the tuckerbox was sculptured by the late Frank Rusconi, but it certainly isn't the the most impressive example of the work of this exceptionally skilled artisan on exhibition in the Gundagai district. In fact one attraction not to be missed at Gundagai is a unique cathedral-in-miniature containing 20,948 individual pieces of marble, every piece cut, turned and polished by hand.

'Rusconi's Marble Masterpiece' took the late Frank Rusconi 28 years of spare time work to build.

Another Rusconi masterpiece on display at Gundagai is his replica of the altar of Saint Marie's Cathedral in Paris.

Rusconi and three other men constructed the original altar whilst he was working in Switzerland.

On returning to Australia he constructed the replica from marble collected from different parts of Australia.

It took him an average of four hours a day for seven years to construct the altar replica.

The Rusconi Marble Masterpiece and the replica of the altar of St Marie's Cathedral are both on display at the Gundagai Tourist Information Centre in Sheridan Street. Inspections can be made Monday to Friday 8 a.m.-5 p.m.; Saturday, Sunday and public holidays 9 a.m.-12 noon and 1 p.m.-5 p.m.

Visitor Information Centre

TOURIST
INFORMATION

Call at the Gundagai Tourist Information Centre situated in Carberry Park, Sheridan Street (opposite the Gundagai Services Club). The centre is open seven days a week (closed Christmas Day) and houses many historical items and special attractions such as the Rusconi Marble Masterpiece, Gemstone Collection and Flood Scenes of Gundagai. Phone (069) 441341 or 442145, Fax (069) 441409.

BRIDGES A SPECIAL FASCINATION

The longest wooden bridge structure ever built in Australia spans the mighty Murrumbidgee River at Gundagai.

This is the Prince Alfred Bridge, built in 1866. The bridge was formally opened in October, 1867, although not completed until 1869. The opening drew people from all over the region. North and South Gundagai had always been at loggerheads, but when brought together by the bridge such a scene was created that it took all the local police as well as visiting constabulary and the military to settle the disturbance.

The bridge formed part of the Hume Highway until replaced by the new Sheahan Bridge 110 years later. The bridge, together with the adjacent historic railway bridge, built in 1901 and opened in 1903, has been classified by the National Trust as a structure whose preservation is essential to Australia's heritage. The railway line closed in 1986. The two bridges provide a special fascination for visitors to Gundagai.

Disastrous Flood

The original Gundagai was surveyed on the wide alluvial flats on the north side of the Murrumbidgee. In 1843 a post office was opened and there were four hotels, several stores, a blacksmith, a school, twenty houses and numerous tents.

On the night of June 23, 1852, the flooded Murrumbidgee River raged through the small township of Old Gundagai, drowning 83 of the 250 inhabitants and destroying 71 buildings.

Many people were saved by Aborigines living in the area, with the hero of that great flood being Yarri, a local Koori from the Wiradjuri tribe.

Throughout the night Yarri continued to ride the one and a half kilometre-wide roaring and raging river as he crouched on his knees on a thin curved bark canoe. Dodging logs that were racing down in the current, and guided by cries of people struggling for their lives, Yarri found his way through the darkness and rescued one after another from rooftops and the branches of trees.

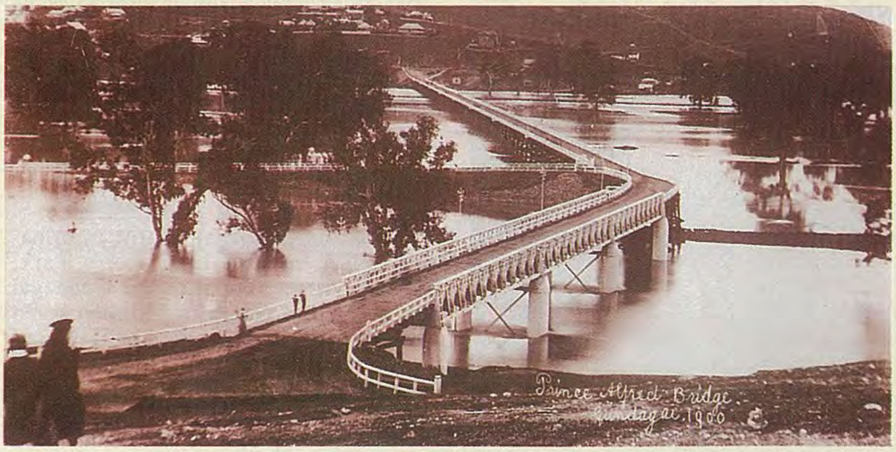
After the 1852 disaster the main township moved to its present position on the slopes of Mount Parnassus, and the view from the top, looking out across that vast flood plain, provides a ready opportunity to visualise the raging river carrying away Old Gundagai.

Visitors are able to call at the Gundagai museum and see some of the old coins and crockery recovered from the site of the flood, and the fascinating gorgets presented to Yarri and another Koori as a reward for their heroic efforts. Inspect the sundial that the Horsley family erected as a tribute to Yarri's resuce of young Fred Horsley, and an inscribed marble plaque erected in memory of Yarri. Take time to read first hand accounts of the flood by a survivor, James Gormly.

Walk up Sheridan Lane and see the only building which still survives the flood, the 3-storey flour mill. See the memorial to Yarri unveiled by the Premier of NSW at the spot where Yarri brought to land many of those he rescued. Cross Yarri Bridge and visit the memorial on the flood plain where the National School stood before it was washed away.

Yarri was buried in the Catholic cemetery at Gundagai on July 24, 1880. Near the gates of the cemetery visitors will see the black marble headstone which was erected in memory of Yarri by the Tumut-Brungle Aboriginal Lands Council.

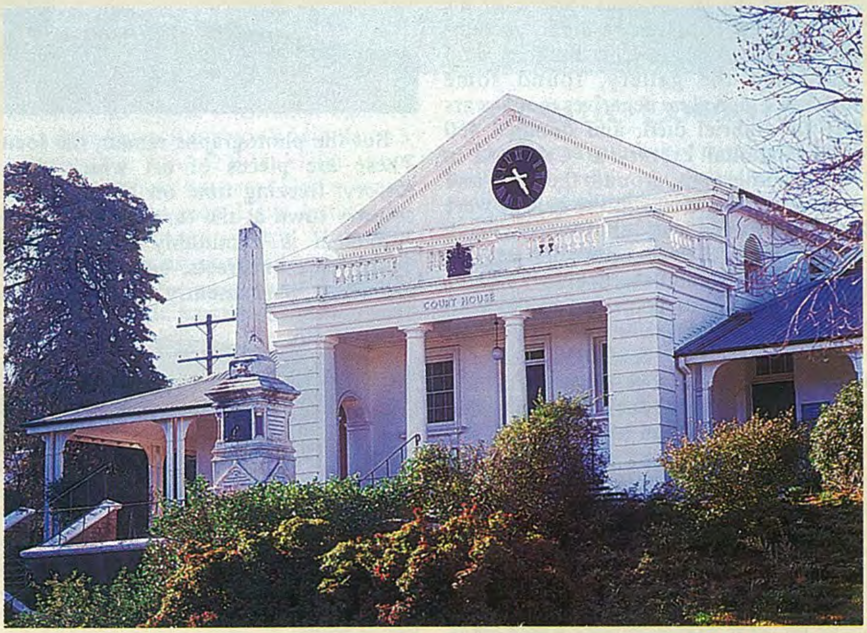
Back in town, the Gabriel Gallery has a special collection of later flood inundation scenes, and for those in a reflective mood there's the opportunity to just rest awhile in Yarri Park.



Prince Alfred Bridge and the Murrumbidgee in flood in 1900.

HERITAGE ARCHITECTURE AT ITS FINEST



Possibly the most imposing building in Gundagai is its magnificent Court House.

Built in 1859 this building is classified by the National Trust as one of great architectural merit.

It has been the scene of many historical court cases, including the trial of the bushranger, Captain Moonlite.

Inspection is available at times other than when court is sitting.

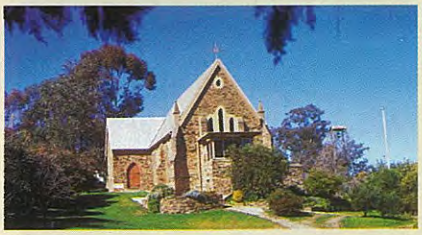
Two other buildings which always generate much admiration by visitors are Gundagai's St John's Anglican Church in Otway Street, and St Patrick's Catholic Church in Sheridan Street.

Built in 1861 the Anglican Church is also classified by the National Trust as a building of historical and architectural merit. St Patrick's opened in 1885.

Inspections can be arranged by phoning 441063 (St John's) and 441029 (St Patrick's).

Visit grand old hotels such as the Family Hotel, where uncovered recently was the sign beside the bar door depicting the establishment's earlier name 'Fry's Hotel', agents at the time for Cobb and Co coaches. Many fine old residences featuring century-old wrought iron and lacework, the old flour mill constructed in 1849, and the magnificent Prince Alfred Bridge (built in 1866) and historical railway viaduct (1901) are also most interesting to visit.

The Gundagai Tourist Information Centre has a National Trust Walk Map available at a small charge. This is an interesting walk around the older streets of the town and will assist you in recognising some of the characteristics relevant to each period of building and architectural changes which have taken place.



FOCUS ON BYGONE DAYS

Gabriel Gallery

A photographic collection of great significance is housed in the Gabriel Gallery, Gundagai, featuring the work of an internationally famous photographer, Dr Charles Louis Gabriel, a distinguished resident of the town from 1887 until his death in 1927. Another resident, accountant and businessman Cliff Butcher, who established the gallery, found some thousand 4 inch glass negatives many years after Dr Gabriel died, and donated 450 to the National Library at Canberra in 1971. Photographs around the wall and on cedar writing desks in the gallery were all printed by the National Library. There is also part of Dr. Gabriel's library, his personal letters and other memorabilia.

Items relating to poets associated with Gundagai — Henry Lawson, Banjo Paterson, Jim Grahame and Jack Moses — are also displayed, together with memorabilia on songwriter Jack O'Hagan, who wrote 'Along the Road to Gundagai'.

Some of Henry Lawson's possessions, such as his walking stick, restored chair, and dictionary, together with his letters to Grace McManus who cared for him in 1920 at Coolac just north of Gundagai, are treasured gallery exhibits. So too is the first X- .ray brought into country NSW by a Dr Mawson, who practised in Gundagai from 1906 (a brother of famous Antarctic explorer Sir Douglas Mawson).

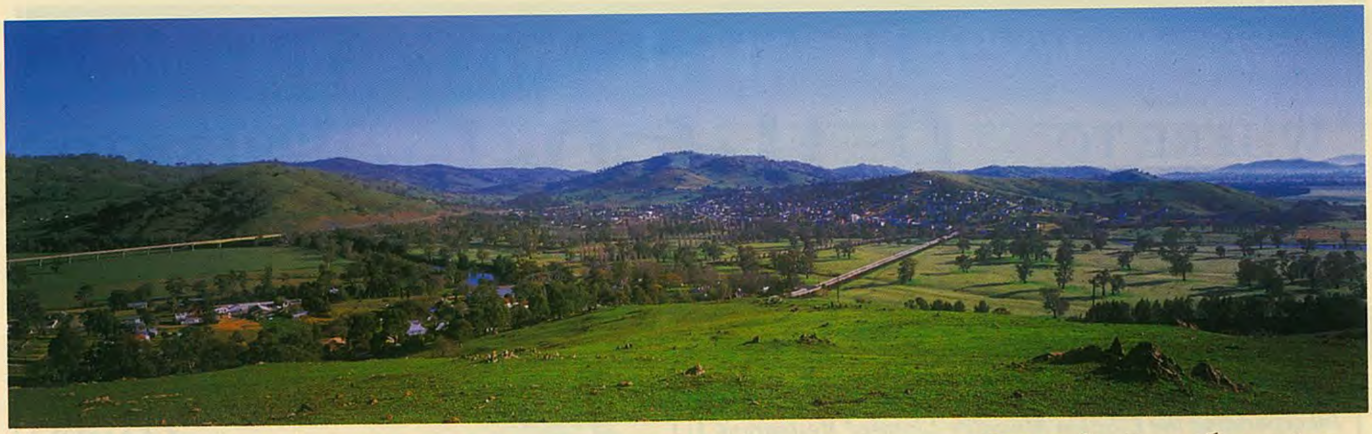
But the photographs remain the focus. These are pieces of art which depict history; freezing time on life in a small country town at the turn of the century. Gundagai is immutably caught in his 'snapshots'; its streets, houses and shops are fixed permanently in phtographic emulsion, its people turn to his lens their slightly self-conscious faces, found working or promenading or gossiping, all intrigued with the novelty of themselves in pictures.

Gabriel's own interests provide a closer focus. A 'new' hospital, the nurses he worked with, the people who were his friends, and the interior of their houses are all recorded.

Between these scenes, and various public events, are photos taken as the doctor drove around in his smart sulky, a witness to funerals, marriages, floods and elections, the coming of trains and circuses. His eye and camera give a very special and irreplaceable record of Australian provincial life two and three generations ago.

Following Mr Butcher's gift to the National Library, president of the Gundagai Historical Society, Mr O. I. Bell, also made a donation of plates which had come into his possession. From the Butcher and Bell collections the library published "Gundagai Days" featuring some 56 photos, and went on to release the more permanent publication "Gundagai Album", which used 120 photographs and was edited by Peter Quartermaine, lecturer in Australian Arts and Letters, University of Exeter. The ABC has also made a 30 minute documentary on the photos, titled A Track Winding Back.

The Gabriel Gallery is located on the first floor of Butcher Roberts Store next to the Westpac Bank in Sheridan St, and is open 9 a.m. to 5.30 p.m. Monday to Friday, and 9 a.m. to 12 noon Saturday. Admission is free.



FAMOUS AUSSIE QUARTET

Dad & Dave, Mum & Mabel

LARGER THAN LIFE

Gundagai's fame in Australian legend, verse and song readily lends itself to the spirit of Dad and Dave. Opposite the 'Dog on the Tuckerbox' is the Snake Gully tourist complex, which enshrines in copper Steele Rudd's four most loveable characters — Dad and Dave, Mum and Mabel, symbolising the indominatable characters and spirit of our pioneers.

Superbly crafted by sculptor Aurel Ragus from beaten copper over steel frames, the statues stand on a pedestal in the park outside the complex, and evoke the character of the type of people they so truly represent. They have become a major attraction in their own right.

Dave is the typical Australian country lad, akin to Banjo Patterson's Middleton's Rouseabout or John O'Brien's Jim; those who know the bush have met Dad at many a stock sale, and seen Dave hitting the turps in many a country pub. Mum and Mabel typify the country woman of a past generation, those great hands in the kitchen who could handle any crisis about the farm work without the aid of their menfolk.

Few Australians have not heard of the characters created by Steele Rudd in his tales of life down on the farm, subsequently made into a series of successful Australian films during the pre-war era, with Bert Bailey immortalising the image of Dad. Later, as a radio serial, Dad and his family became identified with Gundagai when the characters of "Our Selection" were introduced and farwelled to a huge listening audience each day by Jack O'Hagan's 'Road to Gundagai.' The series still runs on some Australian radio stations.

Scenic Lookouts

There are a number of excellent vantage points to view and photograph the township of Gundagai and its environs.

The **Rotary Lookout at South Gundagai** offers a wonderful panorama — the result of a project by the Gundagai Rotary Club.

Magnificient vistas also reward hikers who climb the hill known as **Mt Kimo**, above the Gundagai Caravan Village.

Mt Parnassus provides the summit of the hill on which Gundagai is built. This lookout can be reached by car and provides a delightful view of the town and the rich Murrumbidgee River flats. Alternatively you may decide to reach it by way of a 3 km (round-trip) walk, which takes in historic churches, the old central school building constructed in 1858, and the first hospital in Gundagai, built the same year from local slate stone.

Reno, located 12 kms from the town on the Burra Road, affords a panoramic view of Gundagai and countryside.

Inside the Gundagai Museum.

HISTORICAL MUSEUM

A visit to the Gundagai Historical Museum is a giant leap back in time, with a most interesting and varied collection of machinery, wagons, equipment, a T-model Ford, photographs, clothing, household items and other knick-knacks associated with Gundagai life a century or more ago.

The Museum is located in Homer St, at the rear of the Gundagai Post Office. It is open 9 a.m. to 2 noon Monday to Friday, Saturday 9 a.m. to 2 p.m., Sunday 11 a.m. to 3 p.m. or by appointment. Phone (069) 441995, 441361, 441255 or 442037. Entrance fee is adults $2, children $1, family concession $5.

Phar Lap's saddlecloth — one of thousands of exhibits.

A-C-C-O-M-M-O-D-A-T-I-O-N

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the GUIDE

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The GUIDE D-I-N-I-N-G

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150 Sheridan St., Gundagai

Proprietors: Suzanne and Richard Jones

MURRUMBIDGEE RIVER TRIP

Travel along the Hume Highway north to Coolac, turn right to Gobarralong bridge (15kms), cross the Murrumbidgee, and follow it north through 'Gunnong Jagrawah' (at the homestead you will see the grave of 'Dark Jewel', the greatest brood mare Australia has produced).

Following the river north, you pass through 'Hopewood', thence through 'Warilla' and cross the Murrumbigee again at Jugiong.

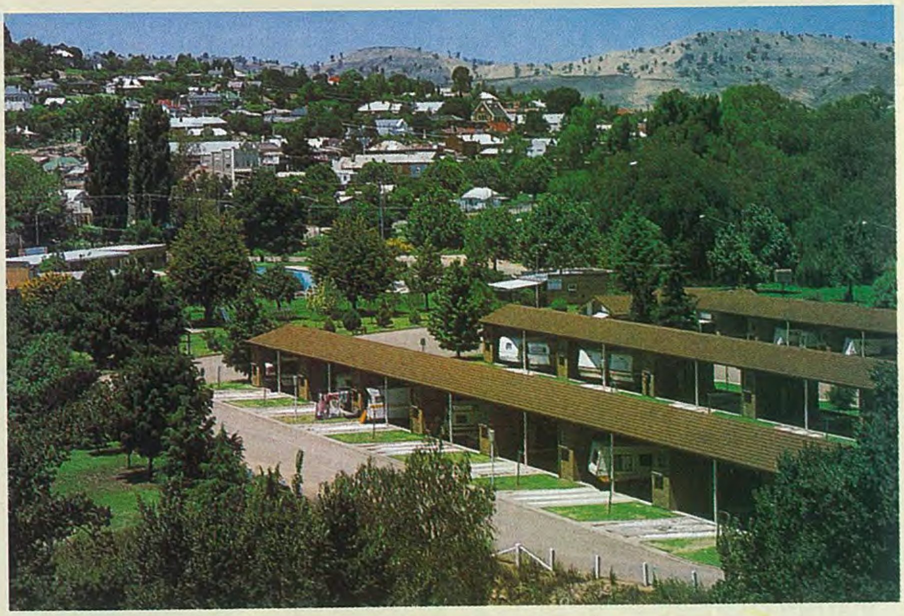
After quenching your thirst at Jugiong's historic Sir George Tavern, drive south on the highway for 7 kms to the cairn on the roadside marking the spot where the bushrangers Gilbert, Hall and Dunn held up the mail coach carrying a large amount of gold from the Gundagai diggings. Sergeant Parry was shot dead in this encounter. (The graves of Sgt Parry and Const. Webb-Bowen, shot in a later encounter with bushrangers, are in the Anglican portion of the Gundagai cemetery). Turn left at this spot and go to the river through 'Cooininee' and 'Gobarralong' properties, coming out at the Gobarralong bridge again.

Alternatively, upon crossing the Murrumbidgee at Gobarralong, follow the bitumen to Adjungbilly. At the Tumorrama Road junction turn right, travel about 15 kms and turn right again to Brungle, down the Brungle Creek valley — a delightful drive. Return to Gundagai via the Brungle Bridge, or drive into Tumut and return through Adelong.

Burrinjuck is another great day trip — the state's first effort at water conservation and one of the dams which enabled the M.I.A. to develop. On the way home call in at Jugiong and look over the South West Pumping Station.

EMERGENCY SERVICES

DOCTOR	443444
DOCTOR	441333
DENTIST	441126
HOSPITAL	441022
AMBULANCE	000
POLICE	441044
FIRE BRIGADE	441077
N.R.M.A.	443099



Gundagai's Caravan Village.

Accommodation

Gundagai has an excellent array of accommodation establishments, ranging from motels, hotels, cabins and caravan parks. The 3½ star Gundagai Caravan Village caters for caravans only with 48 sites and 4 to 6 berth on site vans available. Each site has an individual shower and toilet, all sites have power and TV connections and sullage disposal as well as a host of other first class amenities. Phone 441057.

Clubs and Hotels

The Gundagai District Services Club is situated in Sheridan Street, near West Street, and is open seven days a week (closed only Good Friday and Christmas Day). Its modern facilities include a dining room with Chinese and Australian meals, squash courts, indoor bowls, billiards and snooker. The dining room opens from 12 noon to 2 p.m. and from 6 p.m. each evening, and children are welcome. There is also a snack-bar and take-away service.

The Gundagai Sports Club is situated at the corner of West Street and Sheridan Lane.

Gundagai also has six licensed hotels, with other establishments at Jugiong, Coolac and Tumblong.

All Gundagai hotels — the Royal, Gresham, Criterion and Family in Sheridan Street, and the Hume and Star at South Gundagai — boast a friendly clientelle and serve counter lunches.

The Sir George Tavern at Jugiong, 40 kms north of Gundagai on the Hume highway, is a declared Historical Inn. Built in 1853 it has been in the hands of the Sheahan famiy since its foundation.

The Coolac Hotel, 20 kms north of Gundagai on the Hume Hwy, and the Adelong Crossing Hotel 13 kms south of Gundagai, are old established pubs where there is also a friendly welcome for the tourist.

Service Clubs

ROTARY: Meets Wednesdays at 6.30 p.m. at the Criterion Hotel.

LIONS: Meets second and fourth Mondays at the Gundagai District Services Club.

SOROPTIMIST: Third Tuesday at 7 p.m. Phone (069) 441624.

Transport Services

All major coachlines, such as Fearnes, Firefly, McCafferty's and Greyhound arrive and depart daily from the Gundagai Tourist Information Centre, providing services to all interstate capitals, also Canberra and Wagga.

Makeham's Bus Service to Wagga and return operates Monday to Friday.

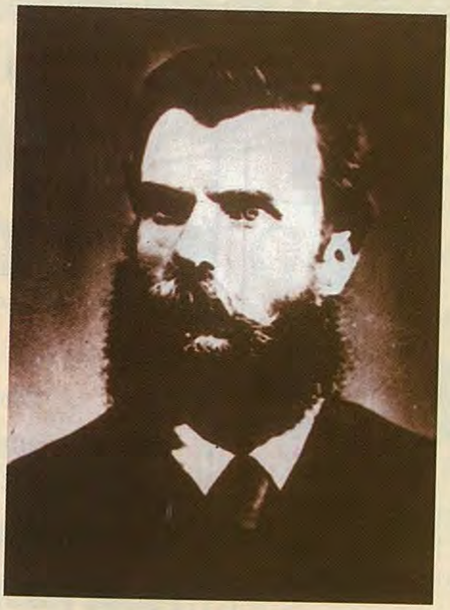
For reservations and enquiries contact the Gundagai Tourist Information Centre (069) 441341 or 442145.

Countrylink services from Sydney and Melbourne arrive and depart every day except Saturday (connects at Cootamundra).

Sheridan St., Gundagai. The town centre boasts a busy shopping centre servicing the needs of locals and visitors alike.

CAPTAIN MOONLITE — BUSHRANGER

Andrew George Scott



Captain Moonlite.

On January 20, 1880, just before he faced the hangman's noose at Sydney's Darlinghurst gaol, Andrew George Scott — better known as Captain Moonlite — wrote "I want to rest in the grave of my friend. Gratify my last wish if you can. Do it in the cheapest manner possible. I have one hour to live."

It took 115 years to grant his last wish, but on Janury 13, 1995, the remains of Captain Moonlite were finally laid to rest in the Anglican section of the North Gundagai cemetery, within metres of the unmarked graves of his friends James Nesbitt and Augustus Wernicke.

Close by is the grave of Constable Edward Mostyn Webb-Bowen, who (along with Nesbitt and Wernicke) was tragically shot in the bushranging siege at Wantabadgery, between Gundagai and Wagga Wagga. Scott called him "brave Bowen".

The year was 1879. Scott, a former lay preacher, had received an early prison release for good behaviour after serving time for bank robbery. (Until death, he protested his innocence of this). He had been forced to abort his controversial public lecture on prison reform, which was to have provided his income. The country was in the grip of a devastating drought. Unemployment was high. Along with hundreds of other men, Scott and his five young friends then tramped the track from homestead to homestead staying alive as best they could.

At Wantabadgery homestead, after twice being refused work, food or shelter despite three days of rain, they drew their weapons and so began the bushranging siege which would go down in Riverina history.

This was the first known, and admitted, attempt at bushranging by these six novice bushrangers, only two of whom could ride. Over a period of three days, 35 people were taken hostage. The women, especially, were treated with respect, and all hostages were released unharmed before the final shootout between the bushrangers and troopers took place.

Scott himself said"We had no intention of being bushrangers . . . misery and hunger produced despair and in one wild hour we proved how much the wretched dare." However, this was a sensational event in troubled times as the Kelly gang had eluded capture in Victoria and public feeling against bushrangers was running high.

Scott and the other three surviving members of his party — Thomas Rogan, Frank Johns and Graham Bennett — were first tried at Gundagai and later in Sydney for shooting Constable Bowen. An eloquent public speaker, Scott conducted his own defence in court and pleaded for the lives of his friends: "I alone commanded and these boys did as I bid them. I am ready to suffer for their sakes and answer for breaking the laws of this country ... Let those who stand beside me go free."

The trial contained much conflicting evidence and was conducted in an atmosphere of public hysteria with over 2000 people crowding the courthouse. The judge sentenced all four "to hang by the neck until your bodies be dead . . . ."

After sentencing, in his final address to the court, Scott said "I ask that my body be given to my friends. I should like my body to be buried in Gundagai."

After appeals, the sentences of Williams and Bennett were reduced to "hard labour for life", but Scott and Rogan were hanged and buried in Sydney's Rookwood cemetery in unmarked graves. It was not until 115 years later that the final chapter in the life of Andrew George Scott was written and he was laid to rest, near his friends, in Gundagai.

Picnic Facilities

Harold Heydon Park, on the corner of Byron and Landon Streets in Gundagai, offers an idyllic setting for a barbecue. Framed by poplar and elm trees, the park has wood burning barbecues, picnic tables and seats.

Excellent facilities have also been developed at Yarri Park, adjacent to Morley's Creek at the corner of Homer and Landon Streets. These facilities include electric barbecues and toilets.

The Gundagai-Adelong Racing Club boasts around twelve race meetings a year on what is fondly called "The Royal of the Riverina" Racecourse.

ENJOY THE FESTIVAL

The Dog on the Tuckerbox annual festival is held every year in November. It is a three day event. Major activities include:

- **FRIDAY:** The Snake Gully Cup race meeting
- **SATURDAY:** The annual Tooheys/Rotary "King of Kimo" run, a 7km cross country taking in the climb up Mt Kimo. Sports dinner at Services Club with sporting celebrities as guest speakers.
- **SUNDAY:** Traditional bush breakfast with the Dog on the Tuckerbox with lots of entertainment.

Another event often held in Gundagai is the state and national Carriage Driving Championships.

A new 18 hole grass green course is the pride of Gundagai's golfing fraternity.

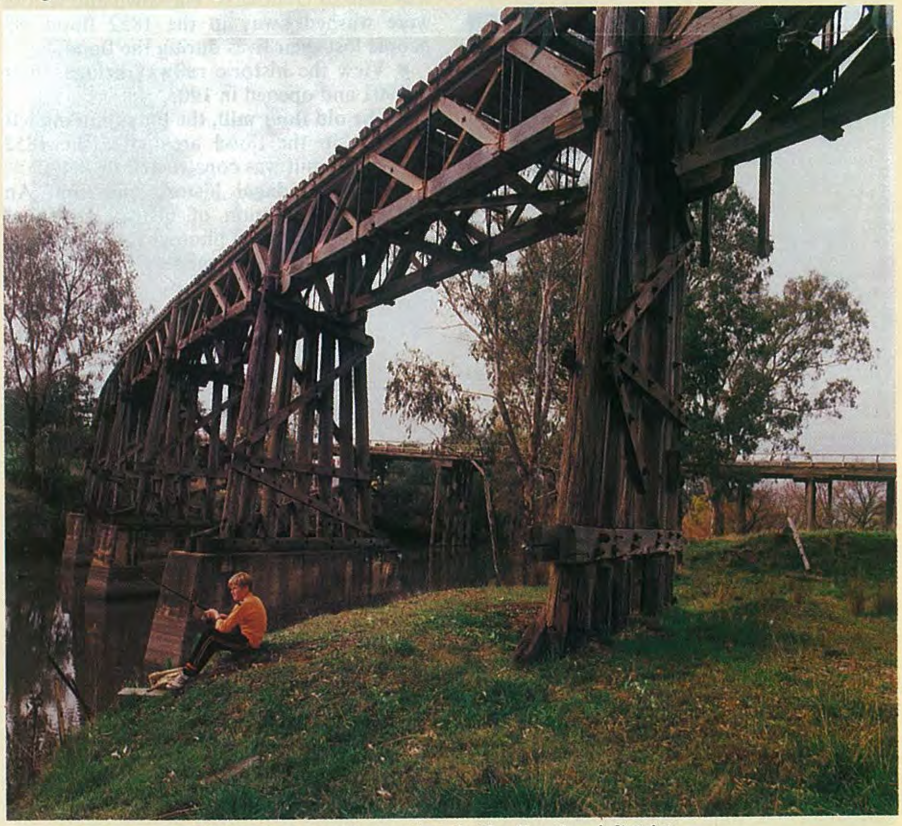
SPORTING FACILITIES

Fishing, boating, bowls, golf, tennis, swimming and squash are just some of the outdoor activities to be enjoyed in Gundagai.

The Murrumbidgee attracts fishermen from many places not blessed with a large river. Nearby also is the Tumut River, and the junction of the two is a favoured spot for trying your luck. The cold water from the Snowy Scheme dams enables the Murrumbidgee at Gundagai to provide a plentiful supply of trout, whilst Murray Cod, Yellow Belly and Bream are in their favourite haunts.

There is a boat ramp close to the Gundagai Caravan Village.

Other excellent fishing streams in the Riverina Highlands include the Goobragandra and Adjungbilly, whilst anglers also enjoy good catches from the Blowering, Jounama, Talbingo and Burrinjuck Dams.



Fishing is a popular pastime in the Gundagai district.

The picturesque 'Bidgee Banks Golf Course nestles between the gums on the banks of the Murrumbidgee River and two creeks which meander their way westward along the riverflat.

The 18 hole grass green course, which measures 5409 metres in length, has a par of 70 and was officially opened in April, 1995.

Golfers are provided with a layout which features an extremely interesting and unique blend of challenging and innocent holes. In most cases distance is generally not a premium during the round. However, the design and natural features of the course will undoubtedly fully test the skill and ability of all golfers.

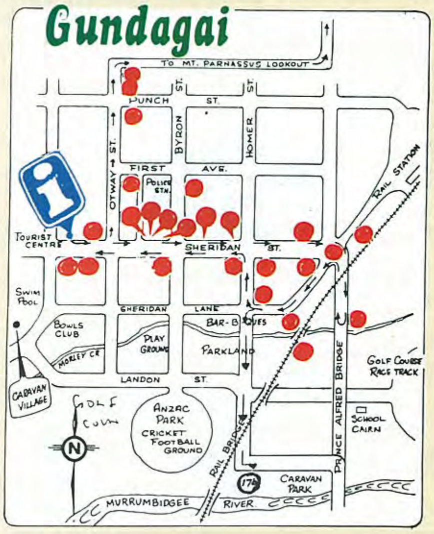
All sporting facilities in the town, including the Olympic pool, are within walking distance from the main street, and include not only golf, but bowls (two greens), tennis, squash, football, cricket and hockey fields.

A TWO FOOT TOUR OF HISTORIC GUNDAGAI

A pleasant 2km stroll viewing many historic points of interest starts and finishes at the Gundagai Tourist Information Centre:

- After viewing **Rusconi's Marble Masterpiece, the Gemstone Collection and Historic Photographs** at the tourist centre.
- **Proceed up Sheridan Street on the left-hand side, walking past Carberry Park,** named after a very popular citizen and shire President for 29 years.

- **The Gundagai Theatre** erected in 1928 by Gundagai Masonic Lodge with the Temple at the rear. Masonry commenced in Gundagai in 1866.
- **The Family Hotel,** built in 1858. Uncovered recently is the sign beside the Bar door proclaiming 'Fry's Hotel', agents at the time for Cobb and Co coaches.
- **Commercial Banking Co of Sydney,** now the National Australia Bank. An outstanding building, this bank was opened in 1877.
- **The Gundagai Galleries on the first floor of Butcher Roberts store beside the Westpac Bank. The Dr. Gabriel Gallery** contains hundreds of photographs of early Gundagai.
- Walkers will notice the old slate wall leading up to the historic former Jail area — not open for inspection.
- The majestic **Gundagai Court House,** built in 1859, with the Boer War monument standing at the top of the steps.
- **The magnificent Catholic Church, St Patrick's,** opened in 1885.



- **The Rural Lands Protection Board** building, now remodelled, is where Frank Rusconi began his marble masterpiece. Visitors will note the local slate stone used at the entrance.
- In this area stands **the Cenotaph,** designed and built by Mr Rusconi.
- **'Rusconi Place'** is directly behind the Cenotaph. This is a dedication to Mr Rusconi for his work and artistry with marble.
- **"Araluen",** the house on the corner, is where Mr Rusconi completed the Masterpiece, and had it on display for many years.
- **Prince Alfred Bridge,** built in 1866, is one of the longest wooden traffic bridges in Australia. From here view the cairn on the flood plain indicating where the first school was built in Gundagai. The town and school were washed away in the 1852 flood. 83 people lost their lives during the flood.
- View the historic **railway bridge,** built in 1901 and opened in 1903.
- **The old flour mill,** the only building left standing in the flood area after the 1852 flood. The mill was constructed in 1849.
- **The Gundagai historic museum.** An interesting collection of historic items of Gundagai, including photographs, clothing, machinery, wagons, T-model Ford and much more.
- **The "Rose Inn" cairn,** marking the site of Gundagai's first building, a public house which was conducted by Thomas Lindley at the time of the disastrous flood in 1852.

- **The Gundagai Post Office and residence,** constructed in 1879. The manual telephone exchange commenced in 1908. Gundagai had the last official 'Pony Express' to deliver mail, a service which ceased in 1984.
- Just past the **Royal Hotel,** the decorative entrance to **"Surrey",** a private home built about 1880 by Mr Billie Payne, a Cobb & Co coach driver.
- Move on down Sheridan Street to the **Criterion Hotel** and view the paintings of the bushranger holdups and the 1852 flood scenes.
- Continue down Sheridan Street to **No. 244.** The restoration work given to this residence is quite a revelation.
- Opposite the tourist centre, walkers may inspect the **Service Club dining room.** This section of the club was erected in 1870 as a flour mill. Visitors will be amazed by the thickness of the walls, built with local slate stone. In the foyer interesting photographs provide more interesting history about Gundagai.

GATEWAY TO

RIVERINA HIGHLANDS

It's a natural

Gundagai is the ideal centre from which to discover the beauty and recreational activities of the Riverina Highlands, taking in such towns as Tumut, Adelong, Batlow, Talbingo, Tumbarumba, Khancoban and Cabramurra .

One days tours from Gundagai provide the opportunity to visit orchards and vineyards, take a first hand look at goldmining heritage, huge timber plantations, historical huts, lakes and rivers, the Snowy Mountains Scheme and its power stations, and enjoy picturesque parks and gardens, the Kosciusko National Park with its magnificent flora and fauna, the Mt Selwyn ski resort, Yarrangobilly Caves, waterfalls, trout farms, superb fishing, the Hume and Hovell walking track, and plenty more.

The adventurous will find plenty to excite them in the form of white water rafting, canoeing, waterskiing, snow skiing, abseiling, flying and caving, whilst a more leisurely pace can be enjoyed on foot or on horseback.

There are two routes to Tumut (via Brungle or Gocup) and from there it's well worth the trip to Lake Blowering and Lake Talbingo where the scenery is spectacular. At Adelong, the Reefer Battery at the Adelong Falls provides an opportunity to step back into the past and follow the golddiggers' footsteps. At Batlow, visit charming apple, pear, cherry, stonefruit and berry orchards which pattern the hills around the town, and also some of the State's largest native and softwood forests. The Batlow Fruit co-operative is one of the largest fruit storage and packing complexes in NSW, whilst the Mountain Maid factory is famous for its fruit and vegetable products.

A shorter Tumut-Batlow-Adelong horseshoe-shaped trip can easily be extended into one also encompassing Talbingo, Kiandra and Tumbarumba. Pick up a Riverina Highlands brochure from the Gundagai tourist centre.

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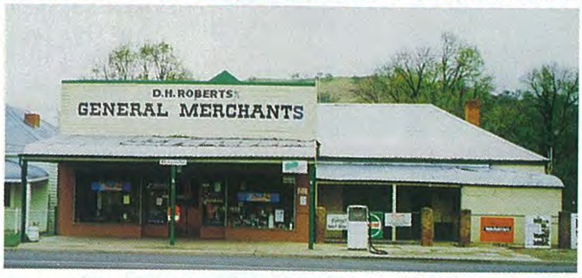

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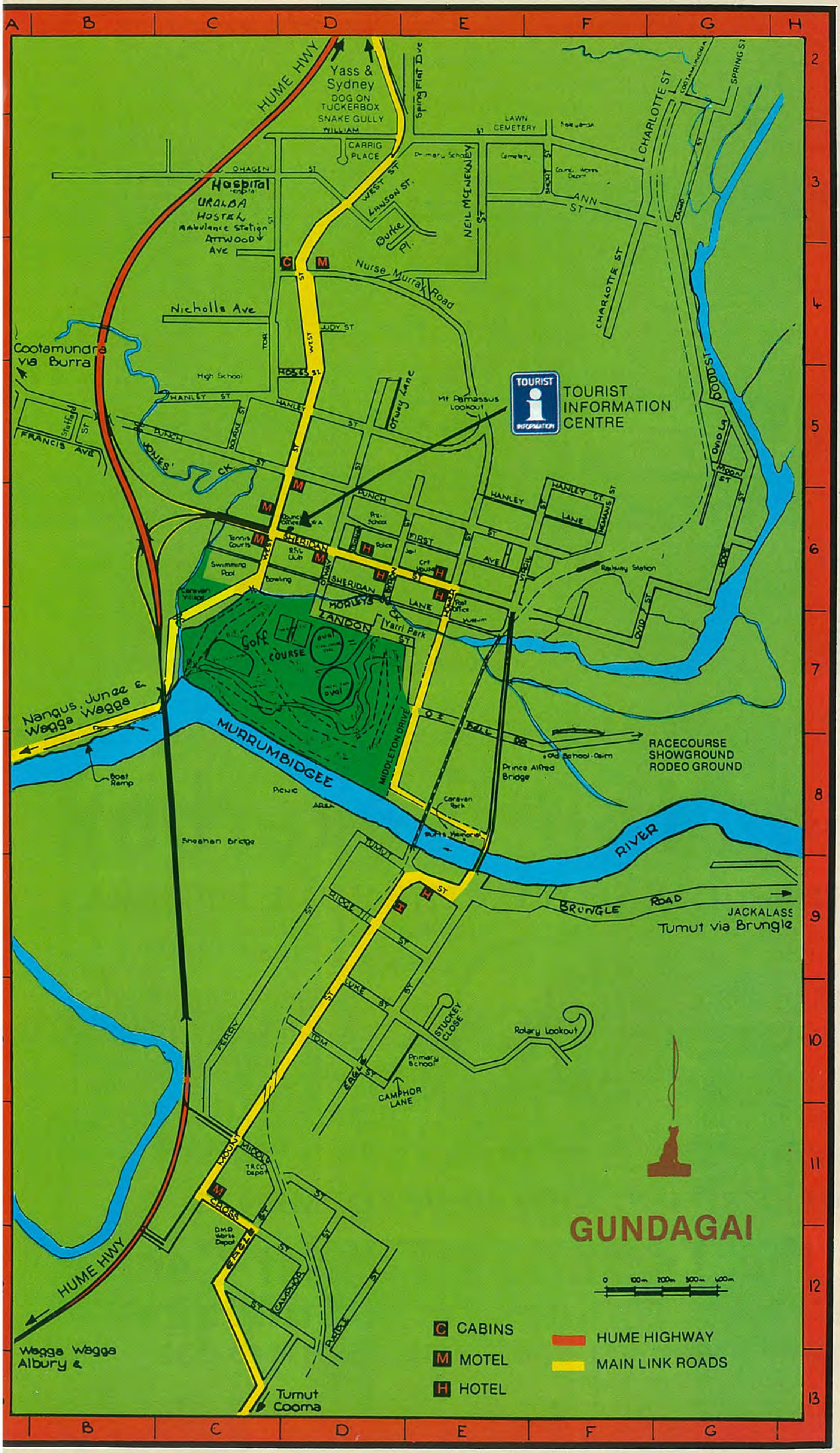

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