PLAQUING NOMINATION
FOR THE

McFARLANE BRIDGE, MACLEAN, NSW
a curved-track bascule bridge

FOR THE AWARD OF A

HISTORIC ENGINEERING MARKER

as part of the centenary celebrations

This historic bridge, with its distinctive tower structure, across the South Arm of the Clarence River was opened on 9 April 1906 (Greg Mashiah photo)

Prepared by Don Fraser for the
Northern Rivers Group
Engineers Australia, Newcastle,
Clarence Valley Council
and the
Maclean District Historical Society Inc.
August 2005

CONTENTS

Plaque Nomination Form

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of Work: **McFarlane Bridge**

The above-mentioned work is nominated to be awarded a

Historic Engineering Marker

Location, including address and map reference:

South Arm of Clarence River at Maclean, NSW

Owner (name and address):

Clarence Valley Council and
the Roads and Traffic Authority NSW

The owner has been advised of this nomination, and agreement identified:

Letters attached

Access to site: **Bridge is in public use**

Nominating Body: **Engineers Australia, Newcastle**

Chairman ***Gunilla Burrowes***

Engineers Australia, Newcastle

Date: **July 2005**

2

From: Greg Mashiah <greg.mashiah@clarence.nsw.gov.au>
Reply-To: <greg.mashiah@clarence.nsw.gov.au>
Organization: Clarence Valley Council
To: "'fraser.don'" <fraser.don@bigpond.com>, <bhonig@engineersaustralia.org.au>
Cc: <peter_mahar@rta.nsw.gov.au>, <marianc@terrigal.net.au>
Date: Thursday, 21 April 2005 10:08 PM
Subject: RE: Plaquing McFarlane Bridge, Maclean

Don & Benita,
At its meeting of 19 April 2005 Council resolved to approve McFarlane Bridge's nomination for plaquing.
Regards
Greg Mashiah
Manager Water and Wastewater
Clarence Valley Council
Ph: (02) 6645 2266
Mobile: 0428 112 982
Fax: (02) 6645 3552
greg.mashiah@clarence.nsw.gov.au
PLEASE NOTE THE @MSC E-MAIL ADDRESSES WILL CEASE WORKING VERY SOON. PLEASE CHECK YOUR ADDRESS BOOK AND CHANGE TO THE ABOVE ADDRESS IF NECESSARY!

-----Original Message-----
From: fraser.don [mailto:fraser.don@bigpond.com]
Sent: Tuesday, 12 April 2005 2:29 AM
To: bhonig@engineersaustralia.org.au
Cc: peter_mahar@rta.nsw.gov.au; greg.mashiah@clarence.nsw.gov.au; deborah.wray@clarence.nsw.gov.au; david.andrews@clarence.nsw.gov.au; marianc@terrigal.net.au
Subject: Plaquing McFarlane Bridge, Maclean

Benita and all,

It is now 12 months to the planned centenary ceremony 9 April 2006, time to start the plaquing process.

Benita is the Secretariat to Engineering Heritage Australia and will pass on the attached "tester"
to the Plaquing Sub-Committee.

Cheers,

Don

98M2034
P B Manampen
Phone 9218 6710

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RTA

Mr Don Fraser
Plaquing Coordinator
Engineering Heritage Committee Sydney
Engineers Australia, Sydney
PO Box 2044
Rose Bay North NSW 2030.

30 MAY 2005

Dear Mr Fraser,

PLAQUING THE McFARLANE BRIDGE (No 2537), MACLEAN

Reference is made to your letter dated 26 April 2005 addressed to the General Manager, Infrastructure Maintenance regarding the proposal for placing a recognition plaque on McFarlane Bridge over the South Arm of the Clarence River at its centenary of opening on 9 April 2006.

I agree in principle to the Engineers Australia proposal for plaquing the bridge with a Historic Engineering Marker at its centenary of opening celebration.

Mr David Bell, Asset Manager, Northern Region is nominated as the contact officer for this project. He will advise on a suitable location and will arrange for installation of the plaque. Further he will be the contact regarding the timing and any arrangements regarding the unveiling ceremony for the plaque.

Mr Bells's contact details are given below:

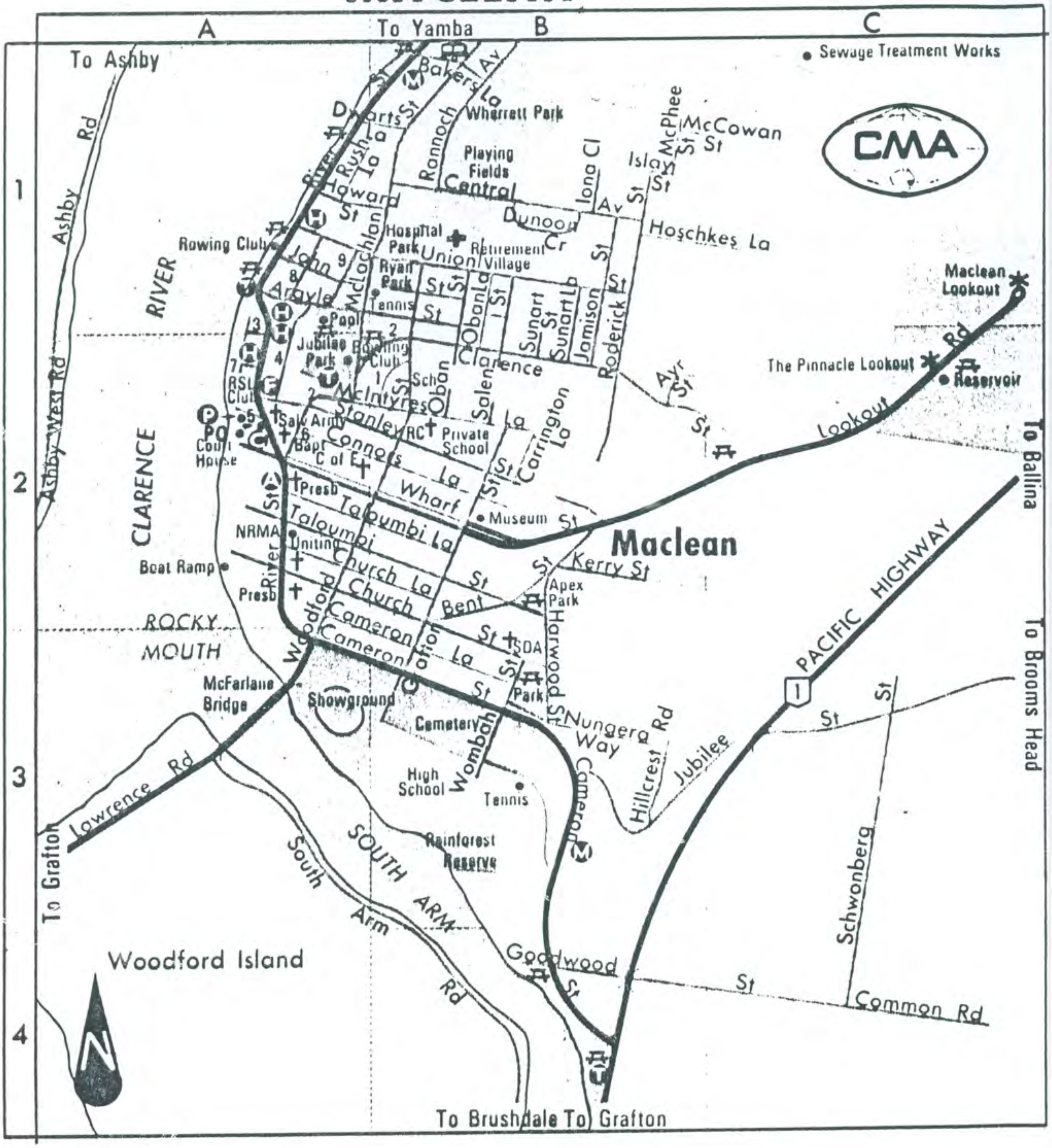
Address:	31 Victoria St GRAFTON, NSW 2460
Telephone:	(02) 6640 1395
Facsimile:	(02) 6640 1004

Yours sincerely

Paul Forward
Chief Executive


G
H
J
K
L
M
Beechworth
Numinbah Valley
Currumbin
Coolangatta
Tweed Heads (57)
Fingal
Banora Point (57)
Springbrook
Tick Gate
Bilambil
Rathdowney
Palen Creek
Tylerville
Glenapp
MT COUGAL
Tomewin
Terranora
Kingscliff
MT MERINO
MT WUPAWN
Chillingham
Tumbulgum
Condong
Tweed River
Bogangar
Murwillumbah (56)
Hastings Point
HWY
Tick Gate
McPHERSON RANGE
Cougal
Tyalgum
Eungella
MT WARNING 1156
MOUNT WARNING NAT. PARK
Stokers Siding
Uki
Pottsville
TWEED RANGE
MT. LINDESAY
Dairy Flat
Woodenbong
Richmond
Loadstone
Mt. Lion
Grevillia
Old Grevillia
The Risk
91
Lynchs Creek
Burringbar
Mooball
Crabbes Creek
56
Wooyung
Billinudgel
New Brighton
+ EDINBURGH CASTLE
Kunghur
Wiangaree
Green Pigeon
MT BURRELL
Doon Doon
JERUSALEM MTN
MT NEVILLE
Brunswick Heads (53)
Mullumbimby
Iron Pot Creek
Kilgra
Fawcetts
Tuntable Falls
Toonumbar
Afterlee
Eden Creek
TOONUMBAR DAM
Richmond River
Kyogle (53)
Cawongla
Nimbin Rocks
Nimbin
ROCKY CREEK DAM
Terania Creek
Coopers Ck
Byron Bay (51)
Cape Byron
Old Bonalbo
RICHMOND RANGE
Ettrick
Cedar Point
Hanging Rock Ck
Goolmangar
The Channon
Federal
Rosebank
Woolners Arm
Back Creek
Dunoon
Bangalow
Baraimal
Corndale
Suffolk Park
Bonalbo
Dyrabba Creek
Rock Valley
Clunes
Newrybar
PACIFIC
Fairy Hill
Bentley
Bexhill
Eltham
Shannon
Lismore (54)
Tuncester
HIGHWAY
36
Teven
Lennox Head
26
Mummulgum
Casino (52)
Piora Brook
BRUXNER
32
Alstonville
44
Ballina (50)
128
HIGHWAY
Mallanganee
Wyrallah
Rous Mill
Empire Vale
Tathum
Leeville
Yorklea
Richmond
Wardell
Creek
35
Amarina
Coraki
MT PIKAPENE
Sandy
River
Coombell
Ellangowan
Broadwater
BROADWATER NATIONAL PARK
Busbys Flat
Bora Ridge
Buckendoon
MT BELMORE + 530
Wyan
Myrtle
Rappville
Creek
Swan Bay
Woodburn
Evans Head
Bundjalung Reserve
Clearfield
Bungawalbin Ck
RANGE
Tick Gate
SOUTH PACIFIC OCEAN
MT MOOKIMA
Baryulgil
552 + MT NEVILLE
Ampdale
RANGE
BUNDJALUNG NATIONAL PARK
Camira Creek
110
HIGHWAY
Esk River
Whiporie
RICHMOND
Tick Gate
95
CORAL SEA
502 + MT MARSH
+ CHAPMANS PEAK
Sportsmans
Banyabba
SUMMERLAND WAY
Wombah
Woody Head
Gordon Brook
Tullymorgan
Fine Flower
Coaldale
Whiteman Creek
Lawrence Road
Chatsworth
Iluka
Clarence River
Harwood
Yamba (50)
Smiths Ck
Gurranang
Maclean (50)
Woodford Leigh
Dilkoon
Creek
Angourie Point
The Blue Pool
Clarence
Lawrence
South Arm
PACIFIC
Woodford Dale
Warragai Creek
Tyndale
YURAYGIR NATIONAL PARK
River
Brushgrove
Ck
Cowper
MT TUCABIA +
Copmanhurst
Southgate
Ulmarra
HIGHWAY
Brooms Head
Carrs Creek
159
Upper Coldstream
Main
38
Tucabia
Sandon
Orara River
GRAFTON (49)
South Grafton
83
YURAYGIR NATIONAL PARK
Pillar Valley
Coffs Harbour
Minnie Water
0
10
20
30
KILOMETRES
N

MACLEAN


A
B
C
1
2
3
4
To Yamba
To Ashby
Sewage Treatment Works
CMA
Ashby Rd
Ashby West Rd
CLARENCE RIVER
ROCKY MOUTH
Wharrett Park
Playing Fields
McCowan St
McPhee St
Islay St
Iona Cl
Central Av
Hoschkes La
Dunoon Cr
Hospital Park
Retirement Village
Union St
Ryan Park
Rowing Club
John St
Argyle St
McLachlan St
Howard St
Rush La
Tennis
Pool
Jubilee Park
Bowling Club
Clarence St
McIntyres La
Stanley St
Oban St
Obanla
Salen La
Sunart St
Sunart Lb
Jamison St
Roderick St
Carrington La
Ayr St
Maclean Lookout
The Pinnacle Lookout
Reservoir
Lookout Rd
To Ballina
To Brooms Head
RSL Club
PO
Court House
Salv Army
Bapt
RC
Private School
Connors La
C of E
Presb
Wharf St
Taloumbi St
Taloumbi La
Museum
Maclean
NRMA
Uniting
Church La
Church St
Kerry St
Apex Park
Boat Ramp
River St
Woodford St
Cameron St
Cameron La
Bent St
SDA
Harwood St
Park
McFarlane Bridge
Showground
Cemetery
Wombah St
Nungera Way
Hillcrest Rd
Jubilee St
PACIFIC HIGHWAY
1
High School
Tennis
Rainforest Reserve
Lawrence Rd
To Grafton
SOUTH ARM
South Arm Rd
Woodford Island
Goodwood St
Schwonberg St
Common Rd
N
To Brushdale
To Grafton

Introduction

McFARLANE BASCULE BRIDGE, MACLEAN NSW
an HISTORIC ENGINEERING MARKER
Opened on 9 April 1906 and representing this class of bridge.


The McFarlane curved-track bascule bridge on the South Arm of the Clarence River at Maclean and its designer Harvey Dare (in senior years)

The concept for this distinctive bascule bridge, with its counterweights rolling down a pair of curved tracks, was first presented in 1729 by Bernard Forest de Belidor. He was an eighteenth-century mathematician and military engineer of the French School whose concern was to simplify the balancing mechanism during operation of the bascule span and to place as much of it as possible within the protection of the fortress gate tower. The mathematical definition of the curved track, so as to give a continuous smooth balanced operation, was the key factor in the design. Belidor suggested part of a sine curve but subsequent analysis showed it to be a cardioid. Friction along curved stone tracks was the main cause of poor performance , few were built.

However, by the 1890s in the USA the basic merits of the concept was recognised and performance was improved by a combination of low friction between cast iron counterweights and steel tracks, better gearing and lubrication, and a practical definition of the curve by a graphical method. A few were built but there were many other competing patented types of bascule bridges in the USA.

Bascule bridges had two important advantages over other types of opening-span bridges such as lift and swing bridges. The two main supporting piers could be located on the edges of the main waterway channel thereby maximising the width and depth of the passageway, and when fully opened, the raised span left clear headroom for tall ships and or masts.

Harvey Dare was one of the celebrated bridge designers of the PWD around 1900 and he recognised the potential for applying bascule bridges to the navigable inland rivers, Murray, Murrumbidgee and Darling, all associated with the River Trade, and the navigable coastal rivers. He adopted and refined the curved track bascule bridge.

The first was the 1902 timber structure at Telegraph Point but all subsequent bridges were steel structures. Coraki was next in 1905 then Maclean in 1906. Eventually 8 of these bridges were built of which only Coraki, Maclean and Carrathool survive plus a tower unit in a park at Darlington Point.

A more complete biosketch of Harvey Dare is included in this Nomination Report. He ended his illustrious engineering career as the first Commissioner of the Water Conservation and Irrigation Commission, NSW.

Plaquing Nomination Assessment Form

Based on RTA S170 Report, Item No 4300642, information supplied by the Maclean District Historical Society Inc and the References.

1. BASIC DATA

Item name:	McFarlane Bridge
Other/Former Names:	South Arm Bridge during 1901 discussions
Location:	South Arm of Clarence River, Maclean, NSW
Address:	Woodford Street, Maclean, NSW
Suburb/Nearest Town:	Maclean, NSW
State:	New South Wales
Local Government Area:	Clarence Valley Council
Owner:	Clarence Valley Council
Current Use:	Road bridge with bascule span locked
Former Use:	Road bridge with operating bascule span for river craft
Designer:	Harvey Dare, Roads and Bridges Branch, PWD, designed during 1902-03
Maker/Builder:	Mountney & Co, Pyrmont, Sydney
Year Started: 1904	**Year Completed:** 1906

Physical Description: A set of original drawings **A to P** is attached in the Appendix.

The main structure of the bridge, over the navigation channel of the South Arm, consists of a 2-span structure of riveted steel truss work for the movable span and the curved-track span, **(dwgs B, H, J, K & L)**. This distinctive structure is flanked on each side by timber beam spans 15 in all, (**dwgs A & E**). The main tower rests on pier (No 11), a pair of 6ft o.d. cast iron cylinders between bedrock and high water then topping cylinders of wrought iron or steel up to the bases of the towers **(dwg C)**. The immediately adjacent piers on each side (Nos 10 and 12) are pairs of Monier concrete pipes 4ft i.d, (**dwg D**). The timber spans are supported by a series of cross-braced pairs of cast iron flanged pipes, (**dwg D**).

Physical Condition: Good – still in use for road traffic and pedestrians. It is maintained by the Roads and Traffic Authority.

Modifications and Dates: In recent years 5 modifications have been made.

1. The bridge has been made inoperative, the movable span has been locked down and the solid cast iron counterweight rollers replaced by hollow replicas.

2. The abutments at Maclean and Woodford Island ends have been completely replaced in concrete, and pier 1 (Maclean end) has been replaced by concrete piles and headstock.

3. Timber spans Nos 13 and 14, immediately on the Grafton side of the movable span, have been strengthened, No 13 by replacing the timber girders with steel UBs, No 14 by inserting UBs between the timber girders, **dwgs N & P**.

4. Each of the cast iron flanged pipe piers have had a concrete collar attached at the wetting range to counter carbon being leached out of the iron.

5. Close on the downstream side of the whole bridge, a line of concrete piles has been driven to support a steel water main.

Historical Notes:

The Lower Clarence and Maclean

The Clarence River (so named officially in late 1839) has the largest coastal river catchment in NSW and the greatest flow. The 'big river' title has been used in informal and praiseworthy terms ever since. In 1838 the abundant red cedar, for which there was a high demand, prompted private citizens to finance visits to the river to exploit this valuable resource. A southern river take-off, a few kms from the river entrance, was later found to be an arm of the main river, hence the name South Arm. It enclosed a large fertile island, now Woodford Island. Maclean was established in 1862 on the north side of the junction, with only an inadequate hand-operated ferry linking it to Woodford Island.

The large fertile flood plain downstream of the future site of Grafton became known as the Lower Clarence. Scottish, Irish and German settlers began to arrive as early as 1840 by which time Capt. Butcher on the *Abercrombie* proved that the river was navigable for about 80 miles (130 kms) from the entrance, truly a big river. The steadily increasing productivity of the "isolated" Lower Clarence, some 440 miles (700 kms) from its principal markets in Sydney, was sustained for 100 years by the "highways of the waters". On the Clarence River, its lower tributaries and the many arms surrounding fertile islands, it was by a flotilla of small craft such as tugs, droghers, barges and punts; and by the frequency of sea-going ships of the North Coast Shipping Trade.

All this changed after 1922 when the all-weather, safer North Coast Railway from Maitland to South Grafton was completed. The river trade lasted another 30 years until road transport on the improving Pacific Highway and on the network of local roads began to reduce the dependency on the river. The railway's most immediate effect was to divert Sydney-destined cargoes and passengers from the vagaries of sea conditions and dangerous bars at river entrances. The North Coast Shipping Trade began to decline as early as 1913 as the railway reached each navigable river from the Manning to the Clarence.

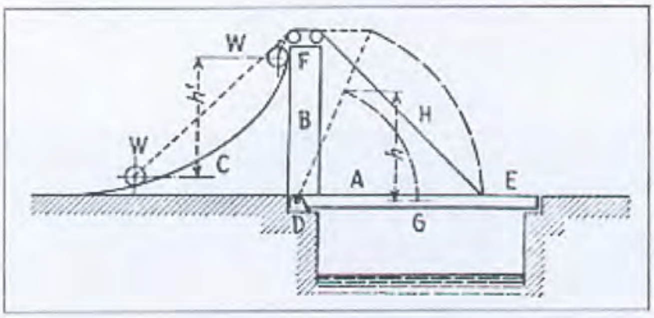
Successive Colonial Governments and the early State Governments had spent millions of pounds on improvement works by the Harbours and Rivers Branch, Public Works Department. Works such as dredging and building river-training walls, entrance breakwaters and lighthouses all along the NSW coast. In 1885 the Colonial Government had engaged British marine engineering expert Sir John Coode to visit the Clarence and other North Coast rivers and to submit a report on recommended improvement works. The Clarence River scheme was approved by the Parliamentary Standing Committee on Public Works in 1889 and work began in 1890 with great expectations. But later State Governments refused to allocate adequate funds particularly after the North Coast Railway was completed, then the Great Depression of the 1930s and World War II intervened, so only essential dredging continued. However, the two large breakwaters were eventually completed by 1969, 80 years after Sir John Coode's scheme was approved.

Despite the lack of a safe entrance at Clarence entrance, the North Coast Shipping was still a busy entity in 1901. Maclean, was only a few kms from the entrance and being the centre of a rich sugar growing area, it steadily developed. The South Arm was busy with waterborne cargoes and passengers and the servicing of villages, towns, farms and factories, particularly sugar mills. At harvest time, high-funnelled steam tugs towing up to 8 punts/barges heavily laden with sugar cane were a frequent sight. Consequently, any bridge across the South Arm between Maclean and Woodford Island had to have an opening-span. John McFarlane MLA, Member for Clarence, continuously promoted the district and lobbied Governments for improvements, the largest of which was the 1906 bascule bridge, named in his honour.

The changeover to low-profile diesel tugs eventually led to the redundancy of the opening span. But it served a degree of usefulness until the 1980s when the combined effect of road transport and the 1966 Harwood Bridge ended the river trade era. The distinctive bascule bridge at Maclean has become an historic engineering relic.

The McFarlane Bridge

The origins of the distinctive style of bascule bridge at Maclean (and at Coraki) go back to France in the first half of the 18th century when engineer/mathematician Bernard Forest de Belidor devised a sophisticated draw bridge (a bascule bridge) for spanning the moats of castles and other fortifications. Smooth operation, through all stages of raising and lowering the movable span, was important thereby minimising the work effort (manual at the time), The see-saw arrangement of the Dutch method, a balanced cantilever beam, was simple and effective but was exposed to attack. Belidor's solution of a pair of curved tracks along which roller counterweights travelled, ensured smooth, balanced operation and had the advantage of being able to locate the tower with its curved attachments, inside the Gate Tower of the castle/fort for protection against attack.



A key piece of information was the equation for the curved track. Belidor suggested a sine curve but analysis by other mathematicians using the new mathematics of differential calculus, showed the curve to be part of a cardioid. Either way, such curves were not practical for setting-out and construction.

Initially the curved tracks were formed with stone, but friction made ideal operation and low-effort impossible, so very few of these novel bascule bridges were built in Europe. However, by the 1890s American bridge engineers revived Belidor's design and with the combination of cast iron counterweights on steel rails, good lubrication of the mechanical elements and a graphical method for determining the correct curve, they produced a low-friction, low-effort system. Quite a few were built and many are still in operation. News and details of this "new" style of bascule bridge were published in contemporary engineering journals which were available to engineers in Australia.

One of the readers was Henry Harvey Dare, a brilliant graduate from the recently established Engineering School at Sydney University under Prof. Warren. He specialised in bridges and recognised the merits of the Americanisation of the Belidor design and the suitability of bascule bridges for the navigable rivers of New South Wales, the Murray-Darling system and the North Coast rivers. His first design was a trial timber structure over the Wilson River at Telegraph Point completed in 1902. He then completed a steel design that was built at seven other sites, the first two being the 1905 Glebe Bridge at Coraki over the Richmond River and the 1906 McFarlane Bridge at Maclean over the South Arm. The only other survivor is the bridge at Carrathool over the Murrumbidgee River. Operationally they were all successful, halving the operating times of other earlier bascule bridges even when operated manually.

A more comprehensive coverage of the curved-track bascule bridge is contained in Fraser and Deakins' paper in the references, a copy attached to the Appendix of the Nomination Report.

Heritage Listings:

Name:	**Title:**	**Number:**	**Date:**
Local Environmental Plan	McFarlane Bridge	81	May 2001
State Heritage Register	McFarlane Bridge	1990081	May 2001
R T A S170 Register	McFarlane Bridge	4300642	Dec 2000
National Trust Register	McFarlane Bridge	2045	

Endorsed Significance — Not recorded but State Significance is likely

2. ASSESSMENT OF SIGNIFICANCE

Historic Phase: The 1906 curved-track bascule bridge at Maclean was built to cater for the steam tugs towing barges of sugar cane on the South Arm of the Clarence River and the sea-going ships that berthed at Maclean. At the time, coastal shipping was still the only viable connection to destinations outside the Clarence District and continued to be until the North Coast Railway reached South Grafton in 1922. The bridge was the third in a series of 8 such bridges designed by PWD bridge engineer Henry Harvey Dare. It is currently the second oldest survivor of its type, there being only two others, at Coraki and Carrathool.

Historic Association: The bridge has historical associations with three important contemporaries, bridge engineer Henry Harvey Dare of the Roads and Bridges Branch, Public Works Department, the contractor Mountney & Co. of Pyrmont who were prominent colonial bridge builders in NSW, and John McFarlane MLA, Member for Clarence in whose honour the bridge was named.

Creative or Technical Achievement: The novel bascule structure was a significant technical achievement from the time of its conception in 18th century France by mathematician-engineer Bernard Forest de Belidor, through to its re-application in the USA in the 1890s and finally its refinement by Harvey Dare in NSW in the early 20th century. The key to its successful smooth, low-effort operation was deriving the correct mathematics for the curve (part of a cardioid) and the practical use of six circular arcs to closely approximate the true curve. Harvey Dare refined the operation to "near perfection" by adding small cast iron discs to the roller counterweights. The bridge is an example of the changeover from British to American bridge technology that had begun in NSW in 1892.

Research Potential: The bridge provides evidence of the interaction of engineering infrastructure and commerce by road and water transport. Its history displays technical improvements that were incorporated into the easy, balanced operation of bascule bridges in NSW. Its characteristics and method of operation are clearly accessible for appreciation.

Aesthetics: The distinctive structure of the bascule bridge sits prominently in the main stream of the South Arm and blends well with its environment. It is a handsome bridge and bears the qualities of a ' gateway' structure.

Social: The bridge has a 100 year history of being a great social asset locally and as a vital link to the productive farms of the Lower Clarence region..

Rarity: The bascule bridge shares rarity – being the second oldest of the three remaining examples of this type of moveable span bridge in NSW. The use of Monier concrete cylinders for two piers of the bascule structure, and the use of cast iron flanged pipes for the piers of the approach spans is comparatively rare.

Representativeness: The bridge represents the on-going changeover from British to American bridge technology around 1900, and the continuing improvements to bascule bridges in NSW.

Integrity/Intactness: The whole bridge (low-level approaches and the bascule structure) is intact. Despite some modifications it retains many features of integrity of the original construction.

References:

Author	**Title**
Maclean District Historical Society Inc	Historical records
Fraser, D	Personal files and records
Newspapers	Articles re opening 9 April 1906
McFarlane, John	A History of the Clarence River District, 1837-1915
McSwan, E H	Discovery and Settlement of the Lower Clarence
McSwan, E H	Maclean – The First Fifty Years
McSwan, E H	The Sugar Industry of the Lower Clarence
Richards, Mike	North Coast Run

Coltheart, L	Between Wind & Water
Coltheart, L and Fraser, D	Landmarks in Public Works
Dare, H H	Recent Road-Bridge Practice in New South Wales, Inst. Civil Engrs., Vol 155, 1903-04
O'Connor, C	Spanning Two Centuries: Historic Bridges of Australia
Fraser, D and Deakin, M A B	Curved Track Bascule Bridges: from Castle Drawbridge to Modern Applications, 7th Historic Bridges Conference, Cleveland, Ohio, USA, Sept 19-22, 2001.
Fraser, D	Moveable Span Bridges in NSW prior to 1915, Inst. Engrs, Aust., 1985
Fraser, D	The First Sixty Years of Metal Bridges in NSW, Inst Engrs,, Aust., 1986
Cardno MBK	Study of Heritage Significance of pre-1930 RTA Controlled Meal Road Bridges in NSW
Austral Archaeology	Heritage Assessment of McFarlane Bridge over Clarence River South Arm
Roads and Traffic Authority, NSW	RTA Heritage and Conservation Register, 4300642

Statement of Significance: (summary of important items from the assessment)

The Maclean bascule bridge has significance under the four principal heritage criteria
- Historical and Association, Technical, Social and Aesthetics.

1(a) **Historically** because it was the third curved-track bascule bridge built in New South Wales to an original concept devised by Bernard Forest de Belidor in 18th century France. It catered for steam tugs and barges laden with sugar cane at the height of the river traffic on the Lower Clarence river system. The McFarlane bridge at Maclean is one of only three surviving curved-track bascule bridges.

1(b) By **Association** with eminent Public Works bridge engineer Henry Harvey Dare, the prominent colonial bridge builder Mountney & Co., and John McFarlane, Member for Clarence.

2. **Technically** because it was a new, sophisticated type of bascule bridge introduced into New South Wales from the USA by Harvey Dare to cater for river craft on navigable waterways. Sophistication came from the mathematics

of the curved track and the practical solution of curve-fitting six sections of circular arcs to approximate the true curve.

3. **Socially** because of its dual service in catering for road and river traffic. It has been a 'gateway' structure for the Lower Clarence farms for 100 years.

4. **Aesthetically** because of its dominant position mid-stream of the wide South Arm of the Clarence River immediately adjacent the township of Maclean. Although no longer operative, it still retains its distinctive tower structure.

Assessed Significance: State

Image with caption:

The distinctive 1906 curved-track bascule bridge on the South Arm at Maclean.

Proposed HEM Plaque Citation:

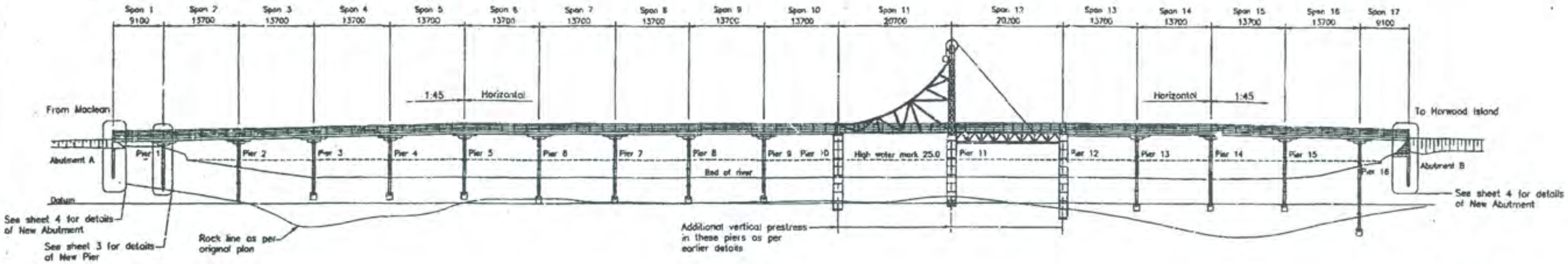
IEAust Logo **HISTORIC ENGINEERING MARKER**

McFarlane Bridge, Maclean

Harvey Dare, Public Works engineer, designed this curved track bascule bridge c1900 based on an 18th century scheme by the French engineer-mathematician B F de Belidor. Dare approximated the correct curve, a cardioid, by six partial circular arcs of varying radii. The bridge was built by Mountney & Co., Pyrmont, opened on 9 April 1906 and named after the local Member, John McFarlane MLA. Of 8 such bridges built in NSW, this and only two others survive. These bridges were built on navigable rivers at the height of the river-coastal shipping trades which were the only 'highways' for many rural communities.
(100 words)

The Institution of Engineers Australia
Clarence Valley Council
Maclean District Historical Society Inc 2006

APPENDICES



ELEVATION
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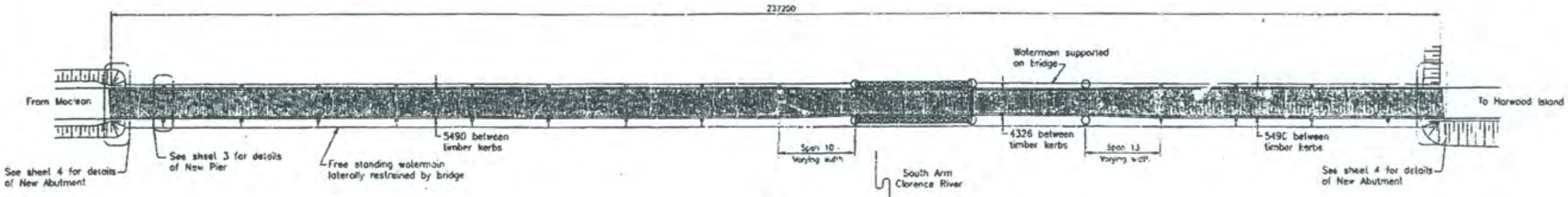
THESE PLANS SHOW WORK AS EXECUTED



PLAN
Scale 1:400

THESE PLANS SHOW WORK

AS EXECUTED

ZONE MANAGER..

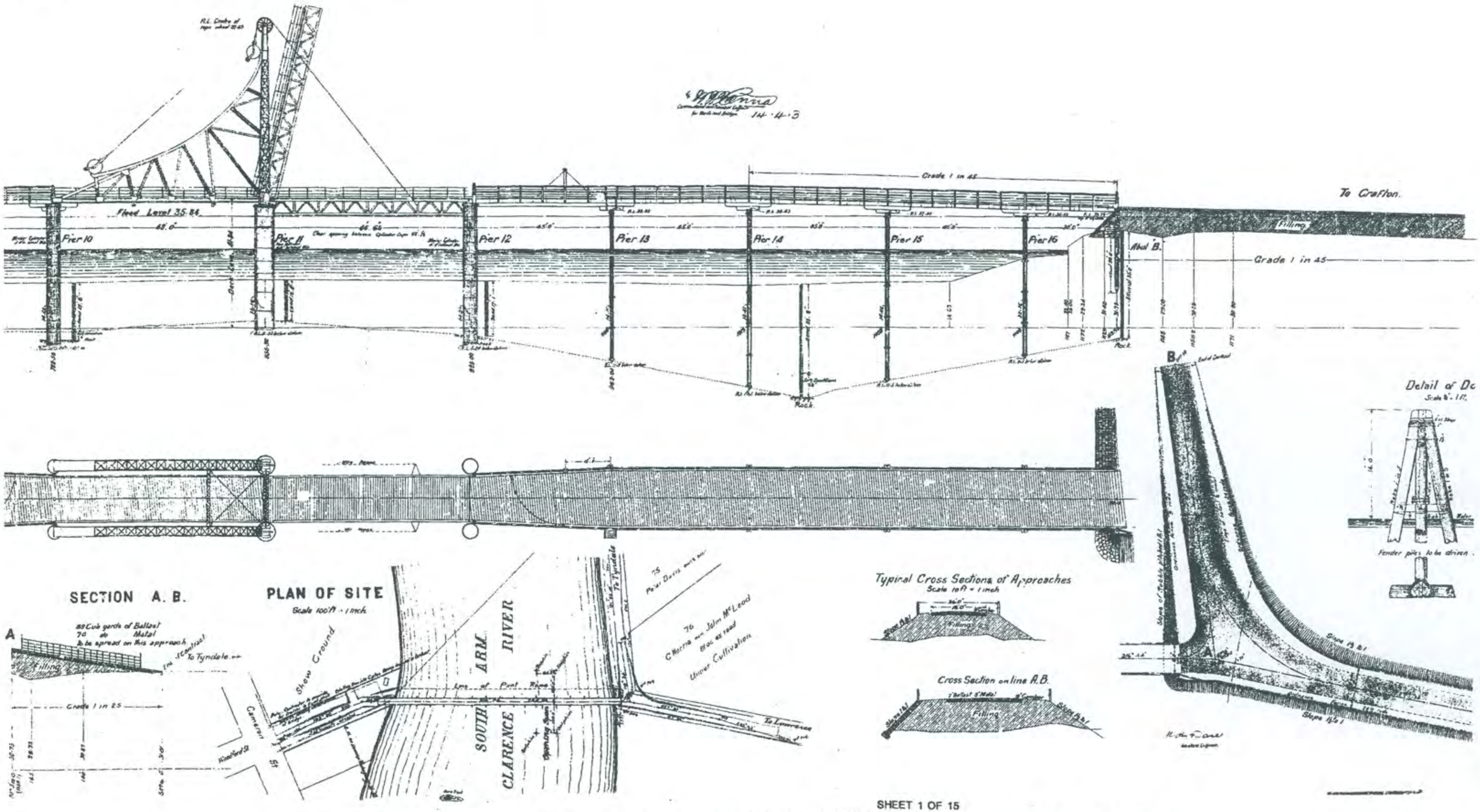
ROADS AND TRAFFIC AUTHORITY N.S.W.		
McFARLANE BRIDGE OVER SOUTH ARM OF CLARENCE RIVER MACLEAN		
GENERAL ARRANGEMENT		
TAYLOR & HERBERT PTY LTD CONSULTING ENGINEERS	REG. No. OF PLANS	0152 274 BC 0102
PREPARED: DESIGN DAH, DRAWING AP	CHECKED	SHEET No. 2 · AMEND. P 1 · No. OF SHEETS 4

CAD FILE F5804 DATE 01-10-02 TIME 15:03 JOB NUMBER

A

.RENCE RIVER AT MACLEAN

ID PLAN



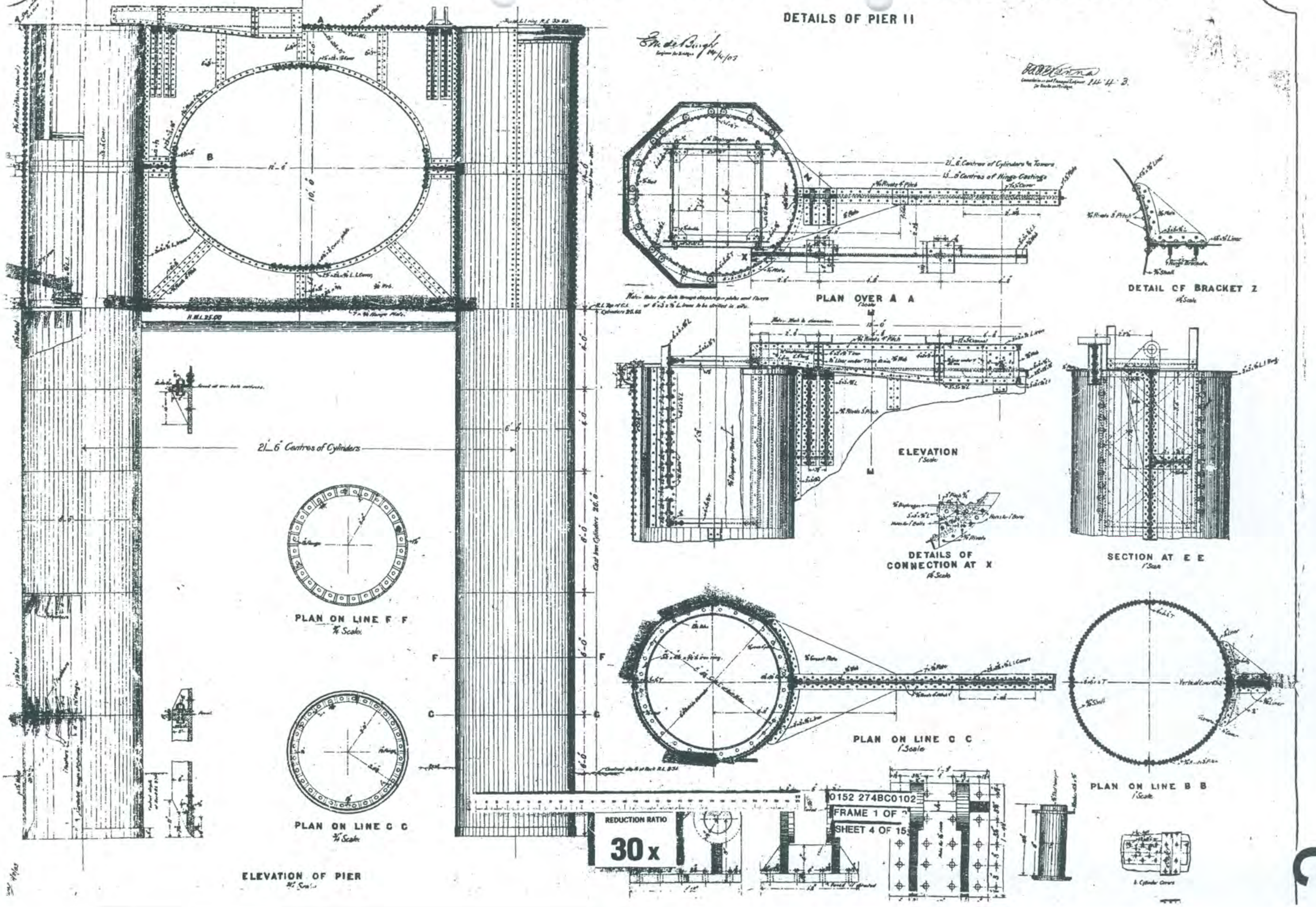
SHEET 1 OF 15

FRAME 3 OF 4 0152 274BC0102

REDUCTION RATIO

30x

No 3 BRIDGE OVER SOUTH ARM CLARENCE RIVER AT MACLEAN

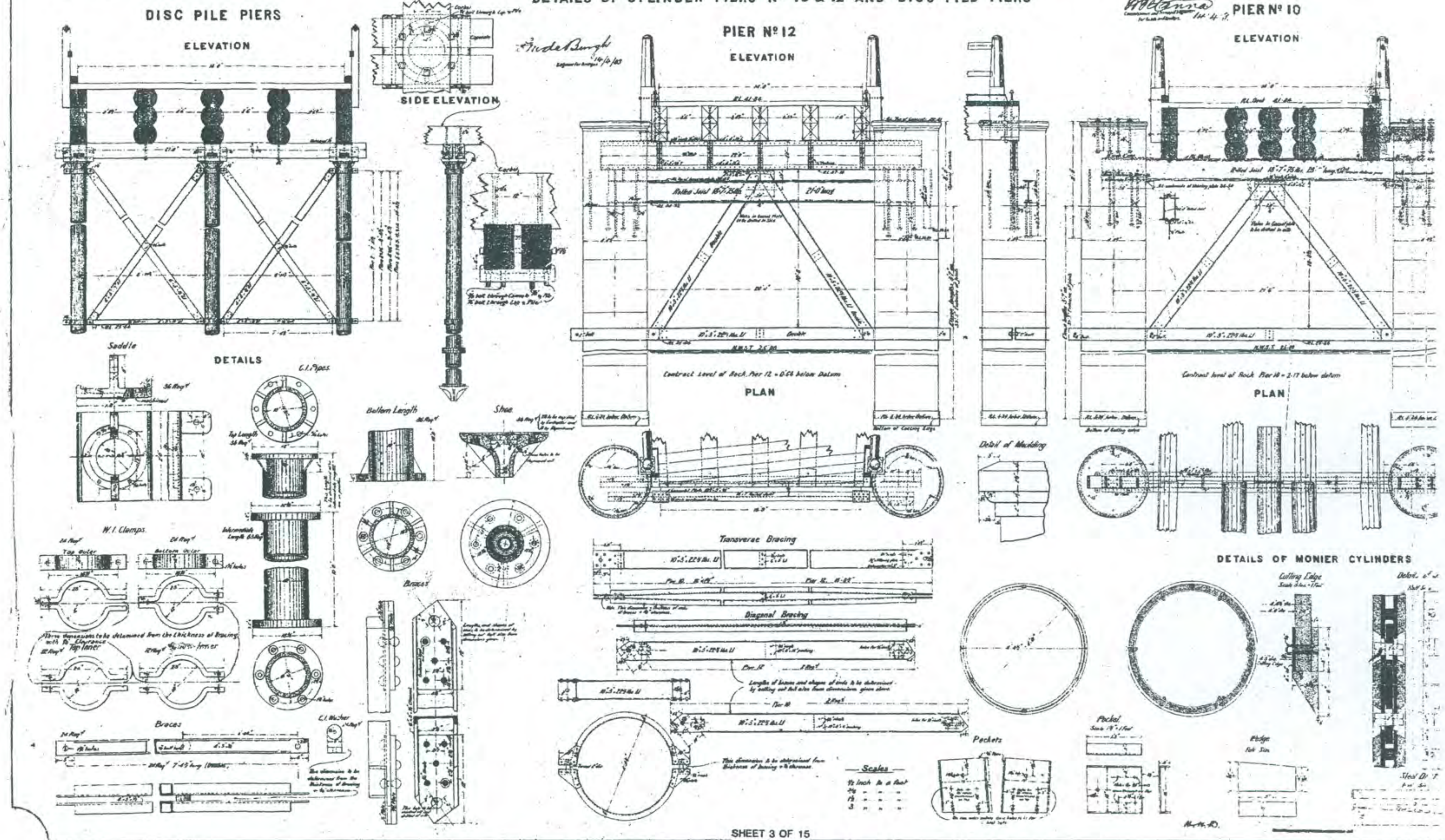


DEPARTMENT OF PUBLIC WORKS
ROADS AND BRIDGES BRANCH

Nº 2

BRIDGE OVER SOUTH ARM CLARENCE RIVER AT MACLEAN

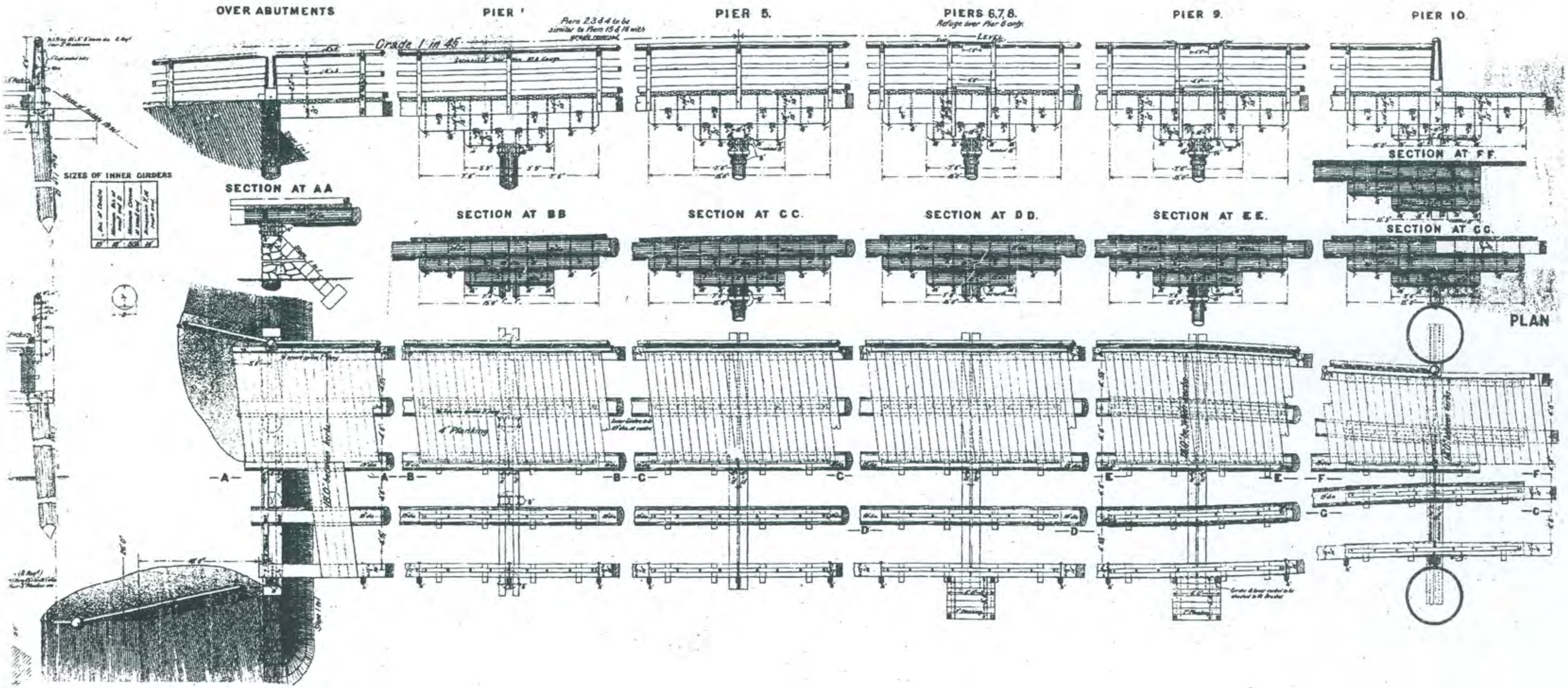
DETAILS OF CYLINDER PIERS Nos 10 & 12 AND DISC PILE PIERS



SHEET 3 OF 15

BRIDGE OVER SOUTH ARM CL

DETAILS OF APPROACH SPANS &



SHEET 9 OF 15

0152 274BC0102 FRAME 2 OF 4

REDUCTION RATIO

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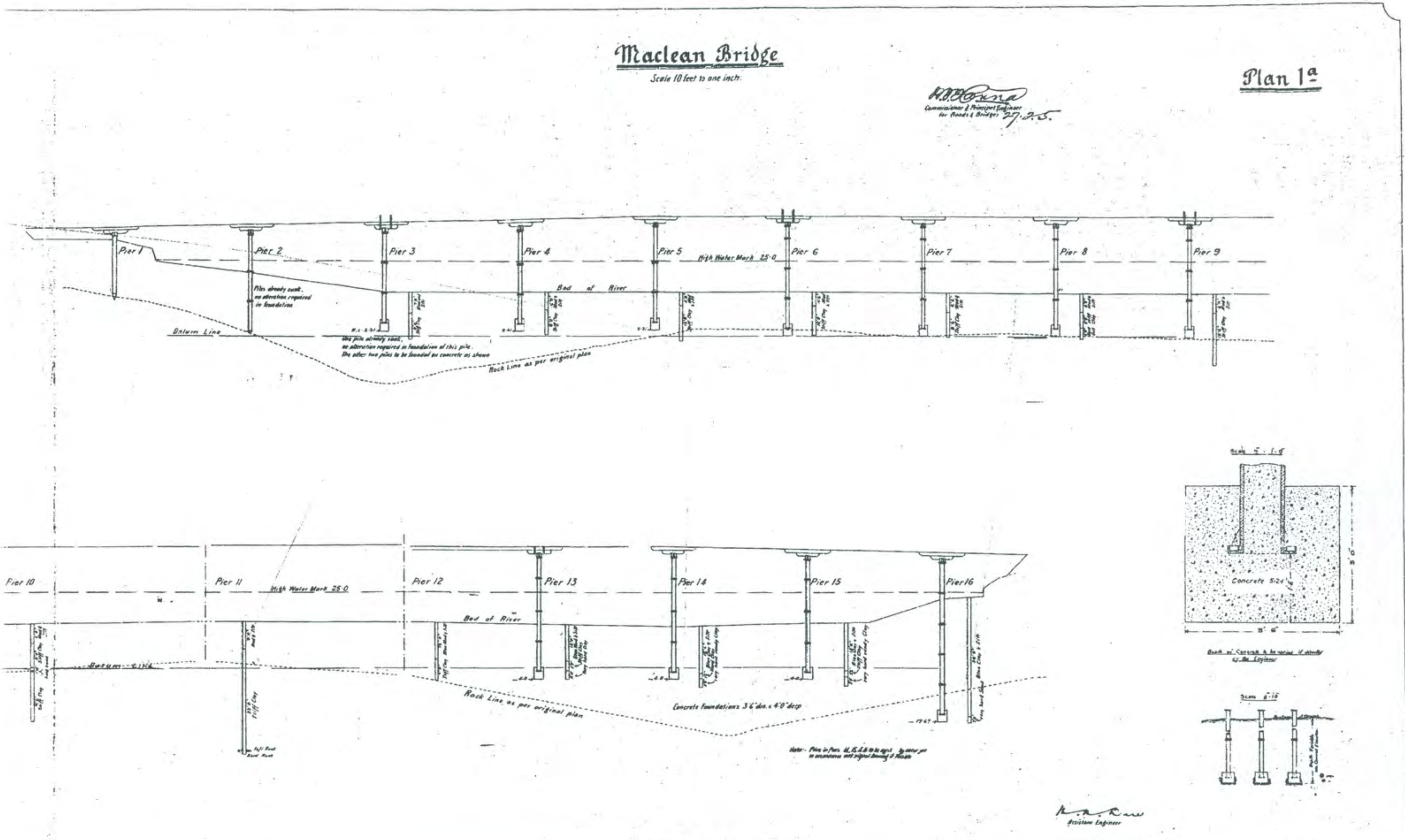


SHEET 2 OF 15

0152 274BC0102

FRAME 2 OF 2

REDUCTION RATIO

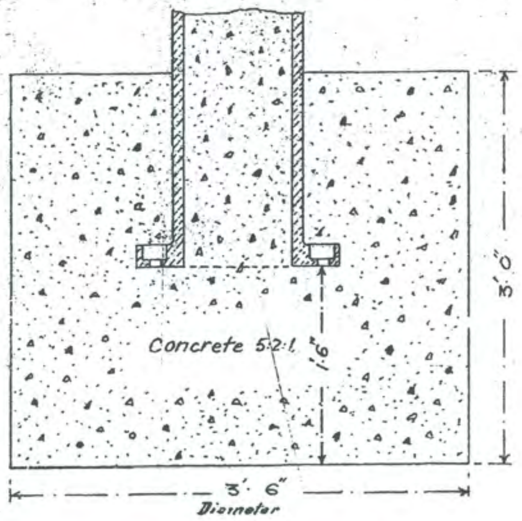
30x

F

MACLEAN BRIDGE — **B.**

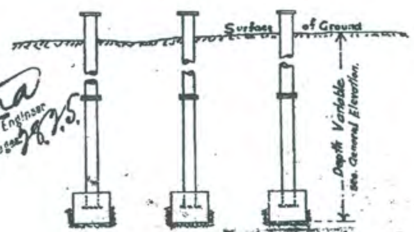
Proposed Concrete Foundation for C.I. Piles

Scale 1½" = 1'0"



Depth of Concrete to be varied if directed by the Engineer

Scale ⅛" = 1'0"



Commissioner and Principal Engineer for Roads and Bridges 28.7.5.

Assistant Engineer.

REDUCTION RATIO

15 x

0152 274BC0102

SHEET 12 OF 15

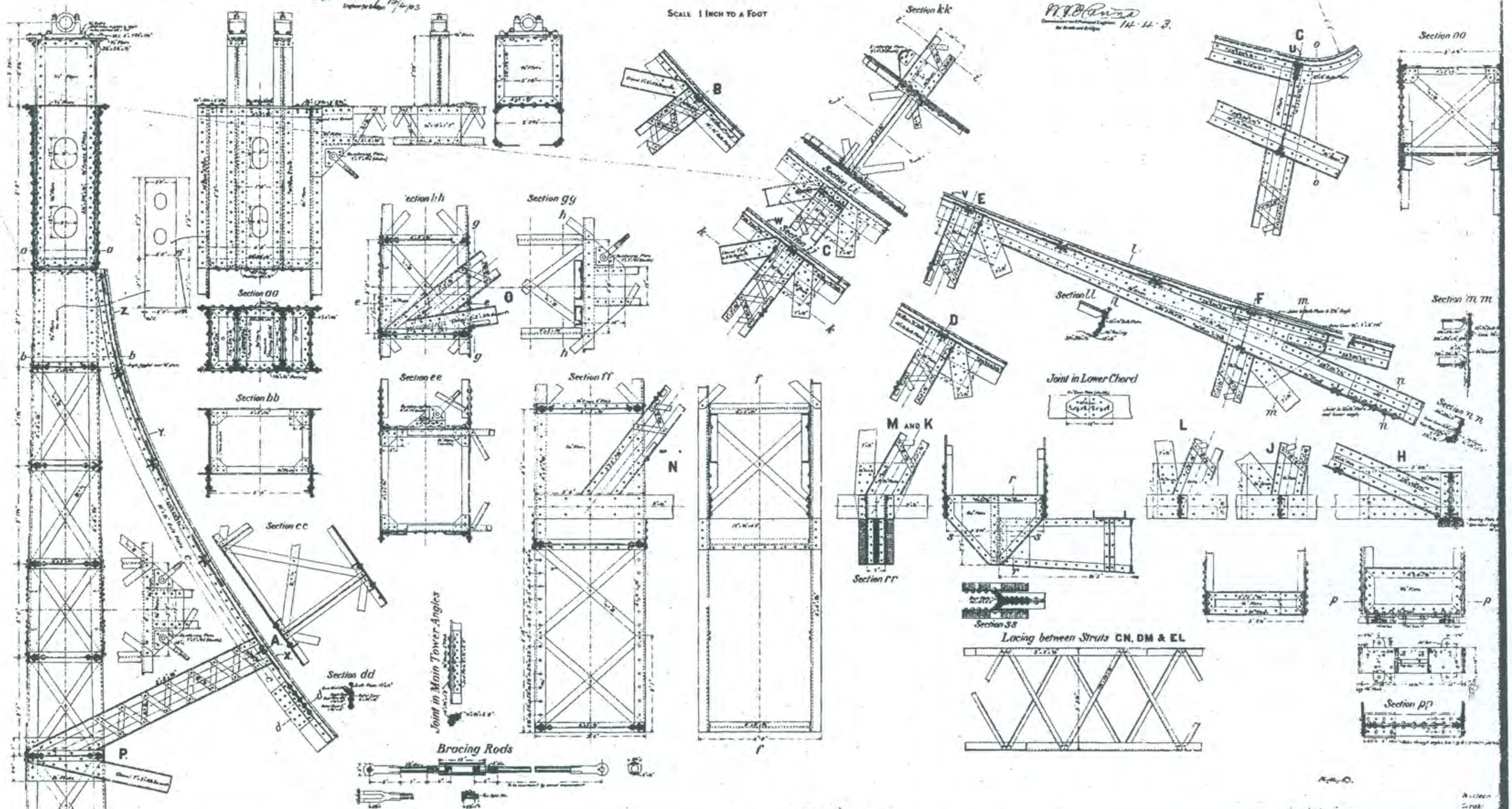
No. 6.

BRIDGE OVER SOUTH ARM RIVER AT

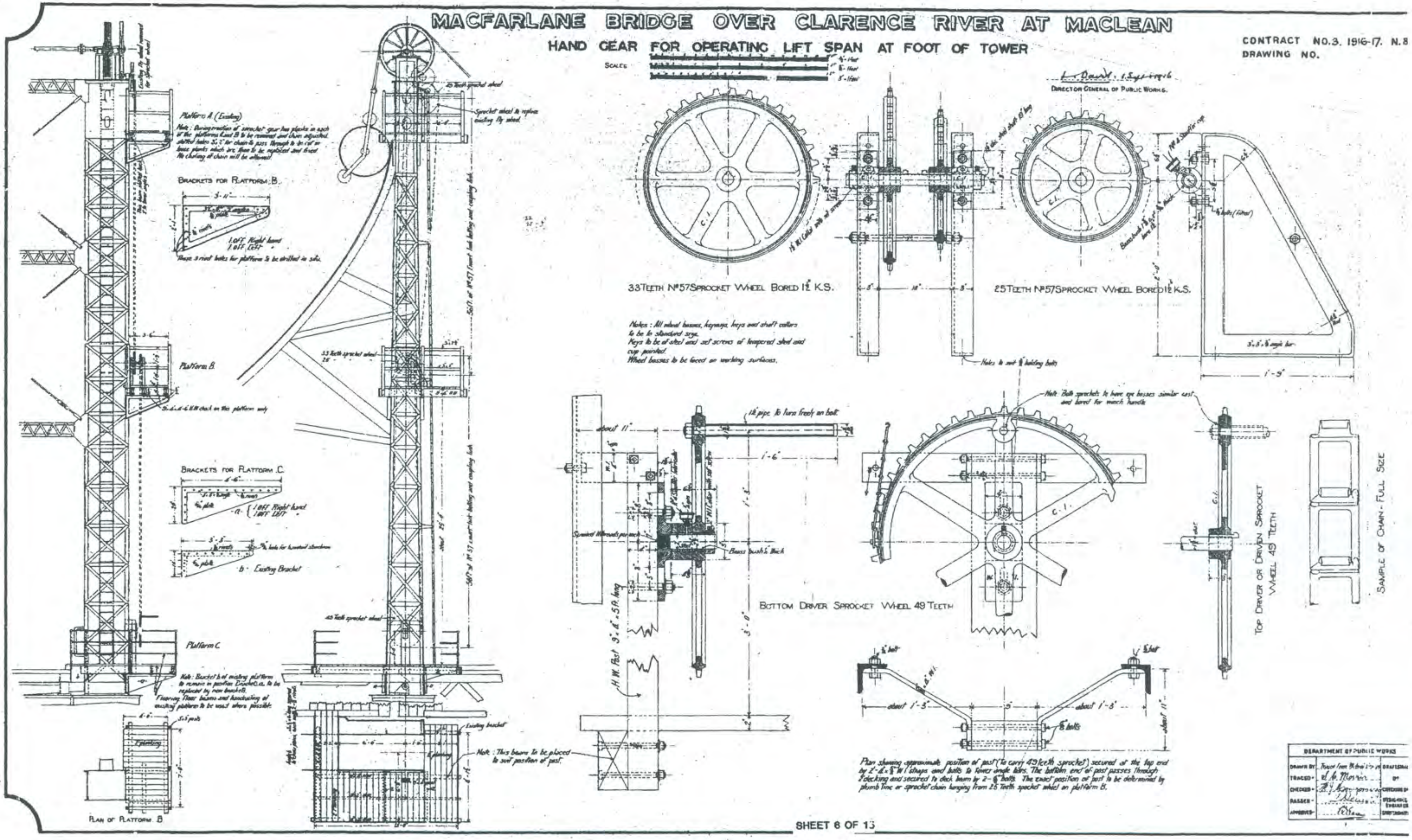
DEPARTMENT OF PUBLIC WORKS
ROADS AND BRIDGES BRANCH

DETAILS OF TOWERS AND TRACK

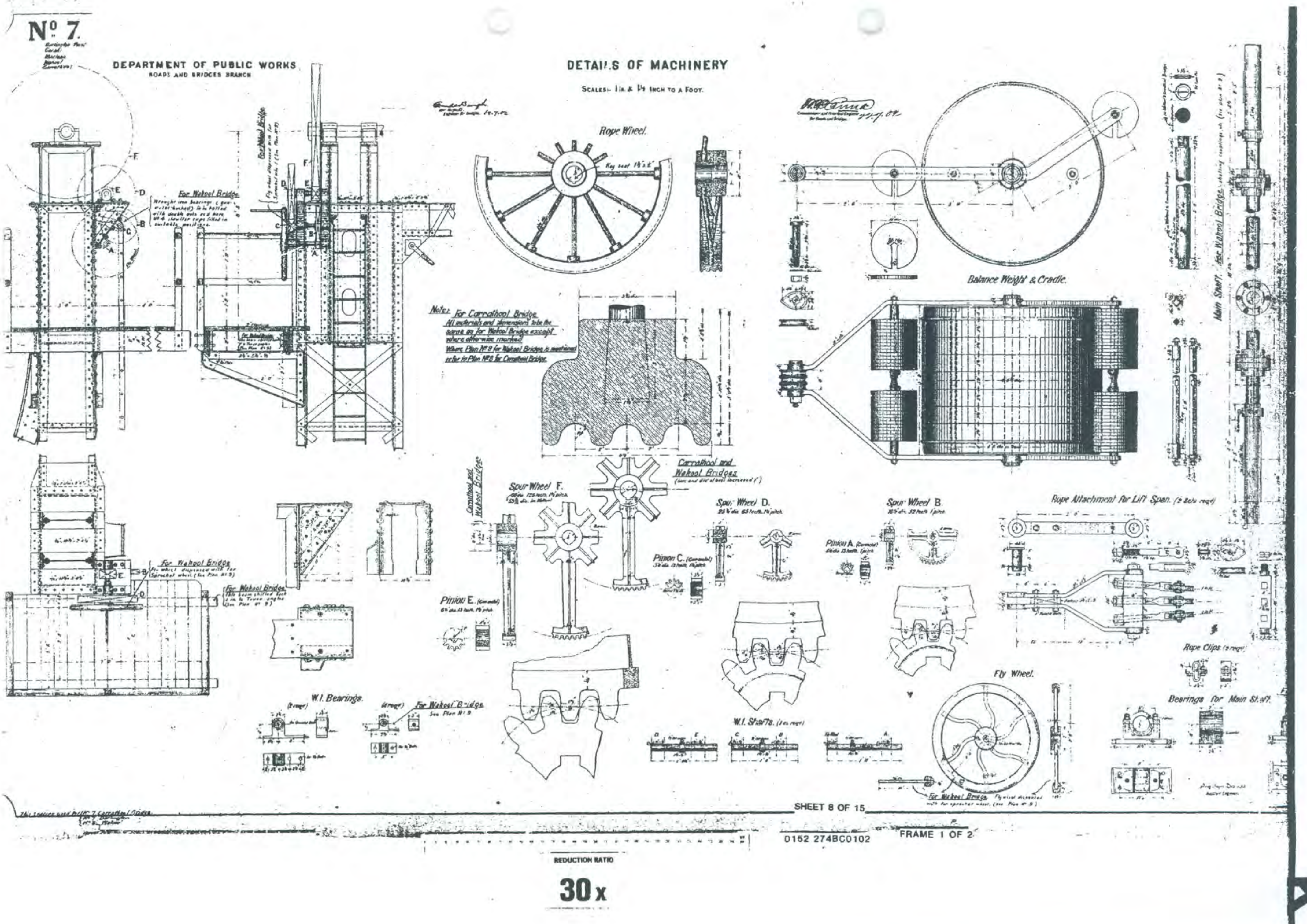
SCALE 1 INCH TO A FOOT



SHEET 7 OF 15



MACFARLANE BRIDGE OVER CLARENCE RIVER AT MACLEAN
HAND GEAR FOR OPERATING LIFT SPAN AT FOOT OF TOWER
CONTRACT NO.3. 1916-17. N.8
DRAWING NO.
SCALE
DIRECTOR GENERAL OF PUBLIC WORKS.
33 TEETH No57 SPROCKET WHEEL BORED 1½ K.S.
25 TEETH No57 SPROCKET WHEEL BORED 1½ K.S.
Notes: All wheel bosses, keyways, keys and shaft collars to be to standard size.
Keys to be of steel and set screws of tempered steel and cup pointed.
Wheel bosses to be faced on working surfaces.
BOTTOM DRIVER SPROCKET WHEEL 49 TEETH
TOP DRIVER OR DRIVEN SPROCKET WHEEL 49 TEETH
SAMPLE OF CHAIN - FULL SIZE
Platform A (Existing)
BRACKETS FOR PLATFORM B
Platform B
BRACKETS FOR PLATFORM C
b - Existing Bracket
Platform C
PLAN OF PLATFORM B
H.W. Post 9" x 4" x 5ft long
Brass bush ¼" thick
Note: This beam to be placed to suit position of post.
Existing bracket
DEPARTMENT OF PUBLIC WORKS
SHEET 6 OF 13
0152 274BC0102
FRAME 1 OF 2
REDUCTION RATIO
30x

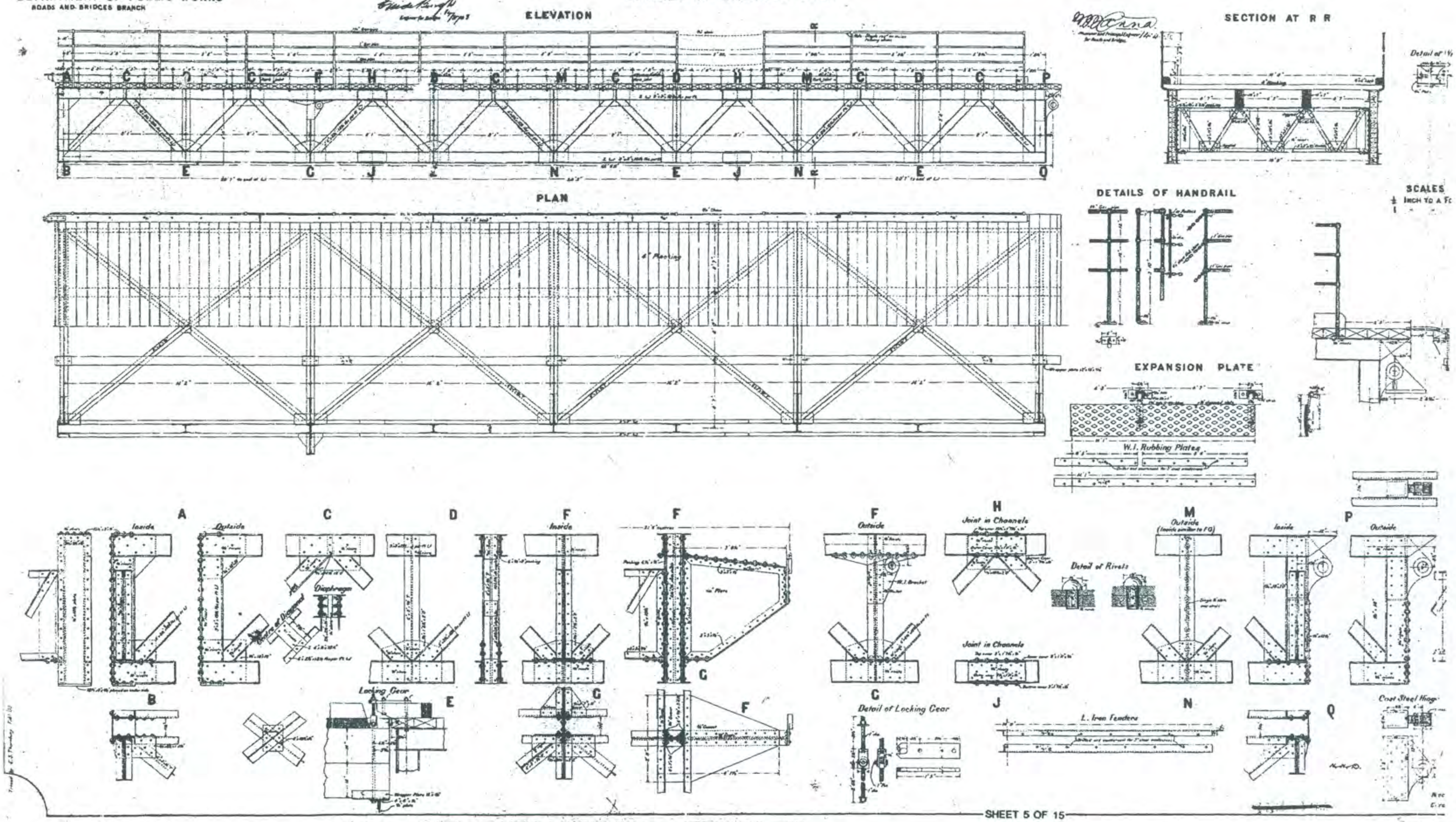


Nº 7.
DEPARTMENT OF PUBLIC WORKS
ROADS AND BRIDGES BRANCH
DETAILS OF MACHINERY
SCALES- 1 IN. & 1½ INCH TO A FOOT.
Rope Wheel.
Balance Weight & Cradle.
Main Shaft. For Wahool Bridge.
Notes For Carrathool Bridge
All materials and dimensions to be the same as for Wahool Bridge except where otherwise marked.
Where Plan Nº 9 for Wahool Bridge is mentioned refer to Plan Nº 8 for Carrathool Bridge.
Carrathool and Wahool Bridges
Spur Wheel F.
Spur Wheel D.
Spur Wheel B.
Pinion A.
Pinion C.
Pinion E.
Rope Attachment for Lift Span.
Rope Clips
Fly Wheel.
Bearings for Main Shaft.
W.I. Bearings.
W.I. Shafts.
For Wahool Bridge
SHEET 8 OF 15
FRAME 1 OF 2
0152 274BC0102
REDUCTION RATIO
30x
K

Nº 4. BRIDGE OVER SOUTH ARM RIVER AT

DEPARTMENT OF PUBLIC WORKS
ROADS AND BRIDGES BRANCH

DETAILS OF BASCULE SPAN

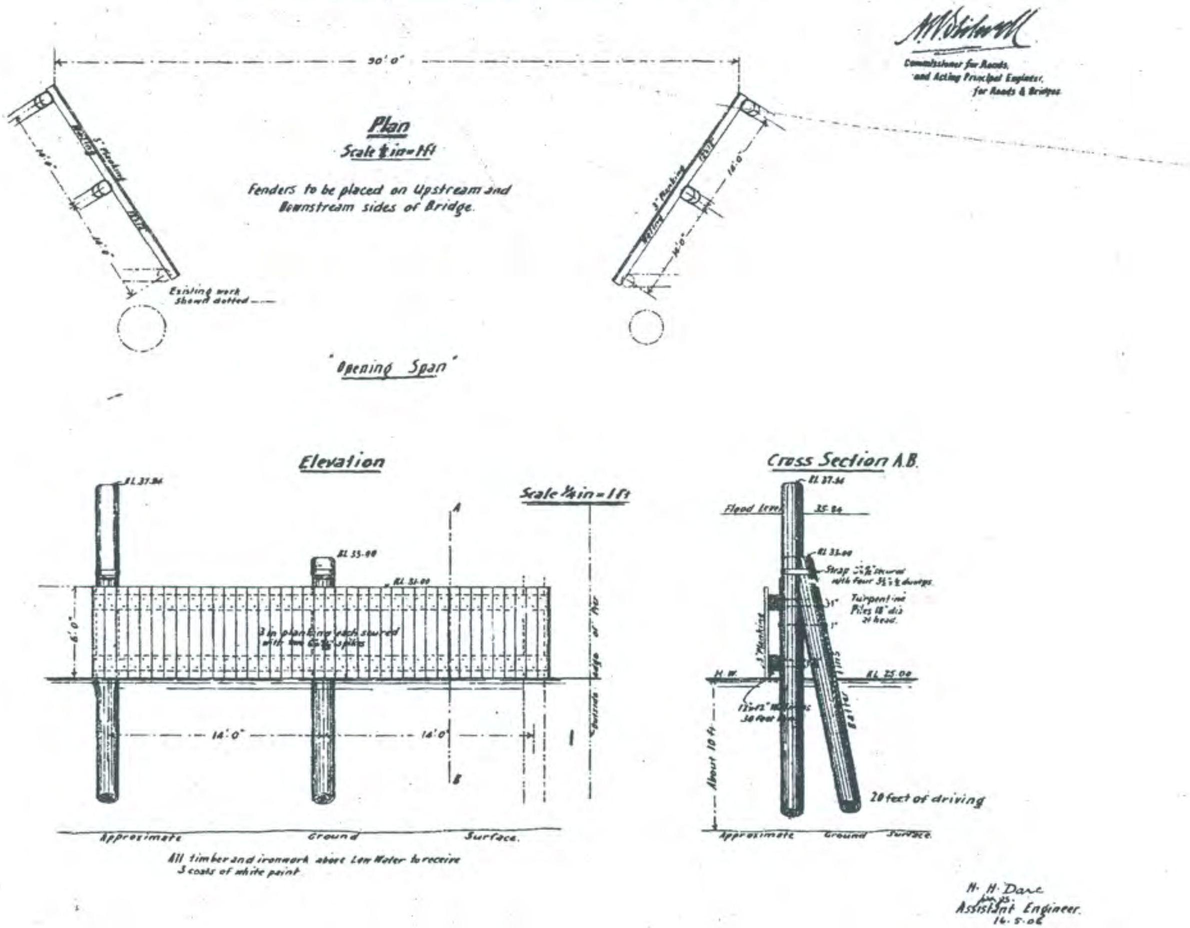


SHEET 5 OF 15

REDUCTION RATIO
30x

0152 274BC0102
FRAME 1 OF 2

Fenders for Maclean Bridge



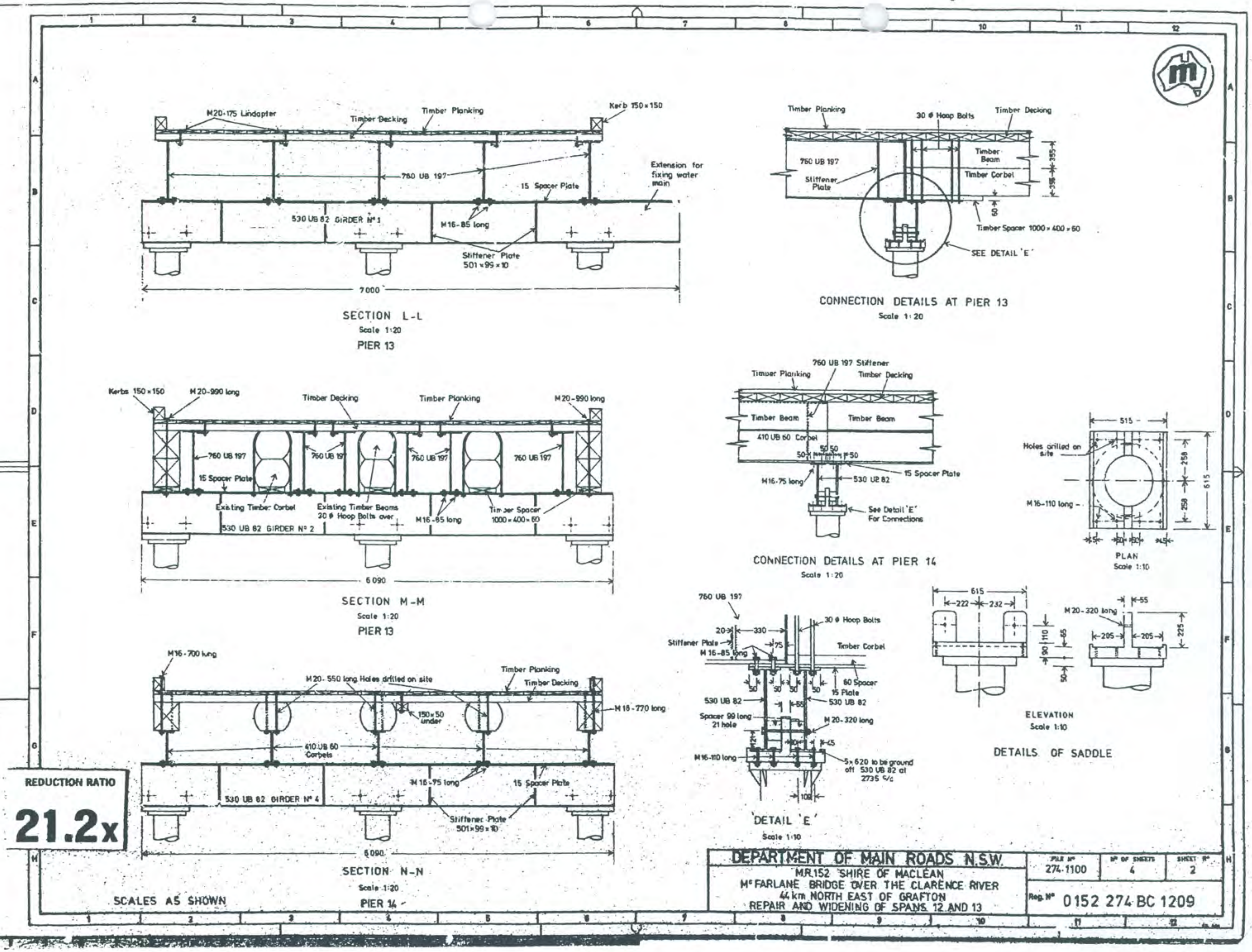
SHEET 14 OF 15

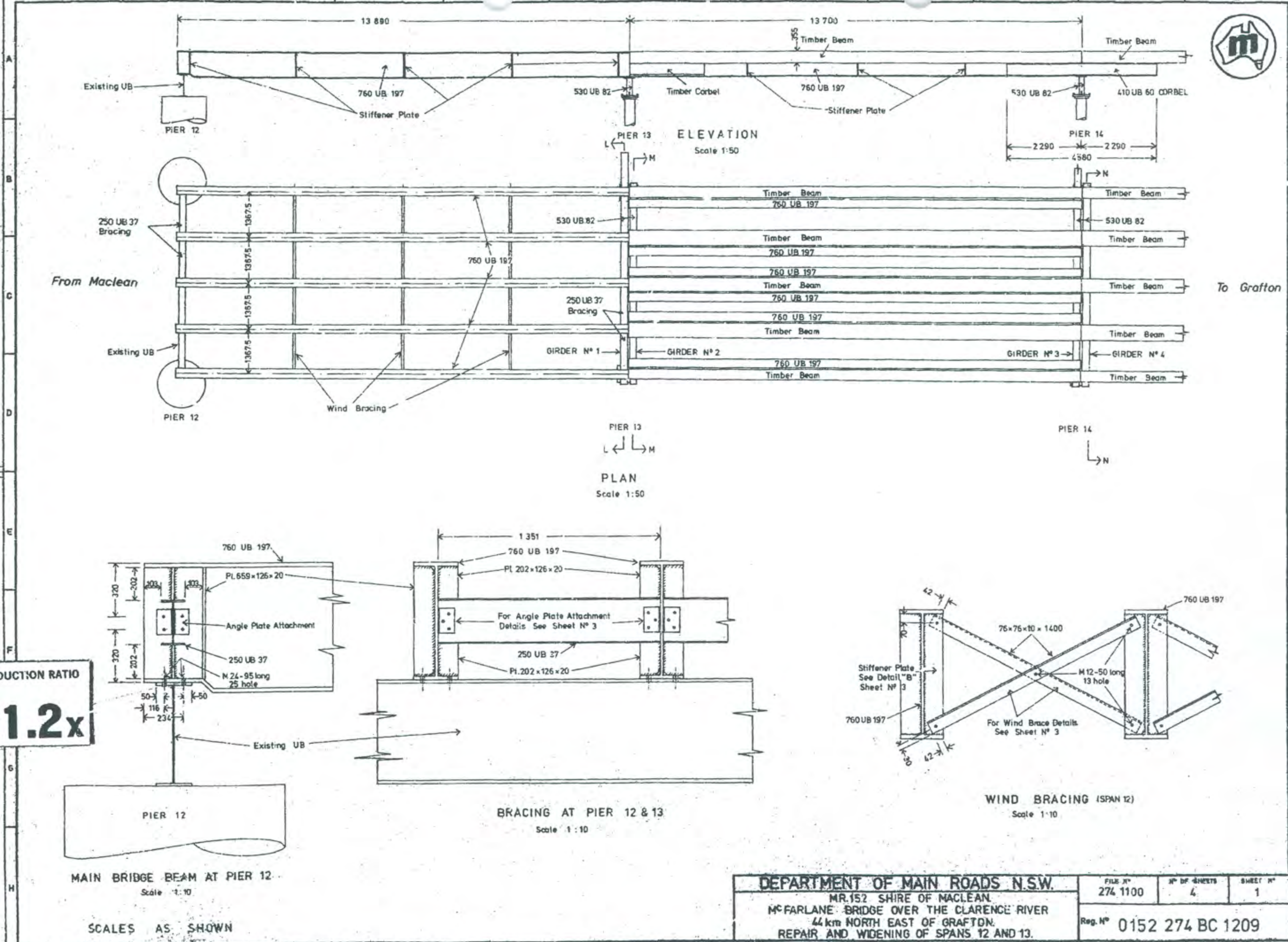
REDUCTION RATIO

21.2x

0152 274BC0102

M


M20-175 Lindapter
Timber Decking
Timber Planking
Kerb 150×150
760 UB 197
15 Spacer Plate
Extension for fixing water main
530 UB 82 GIRDER Nº 1
M16-85 long
Stiffener Plate 501×99×10
7000
SECTION L-L
Scale 1:20
PIER 13
Timber Planking
30 ø Hoop Bolts
Timber Decking
Timber Beam
Timber Corbel
Stiffener Plate
Timber Spacer 1000×400×60
SEE DETAIL 'E'
CONNECTION DETAILS AT PIER 13
Scale 1:20
Kerbs 150×150
M20-990 long
Timber Decking
Timber Planking
M20-990 long
760 UB 197
15 Spacer Plate
Existing Timber Corbel
Existing Timber Beams 20 ø Hoop Bolts over
M16-85 long
Timber Spacer 1000×400×60
530 UB 82 GIRDER Nº 2
6 090
SECTION M-M
Scale 1:20
PIER 13
760 UB 197 Stiffener
Timber Planking
Timber Decking
Timber Beam
Timber Beam
410 UB 60 Corbel
15 Spacer Plate
M16-75 long
530 UB 82
See Detail 'E' For Connections
CONNECTION DETAILS AT PIER 14
Scale 1:20
Holes drilled on site
M16-110 long
515
258
PLAN
Scale 1:10
M16-700 long
M20-550 long Holes drilled on site
Timber Planking
Timber Decking
M16-770 long
150×50 under
410 UB 60 Corbels
M16-75 long
15 Spacer Plate
530 UB 82 GIRDER Nº 4
Stiffener Plate 501×99×10
6 090
SECTION N-N
Scale 1:20
PIER 14
760 UB 197
30 ø Hoop Bolts
Stiffener Plate
M16-85 long
Timber Corbel
60 Spacer
15 Plate
530 UB 82
530 UB 82
Spacer 99 long 21 hole
M20-320 long
M16-110 long
5×620 to be ground off 530 UB 82 at 2735 c/c
DETAIL 'E'
Scale 1:10
615
222
232
M20-320 long
205
205
225
ELEVATION
Scale 1:10
DETAILS OF SADDLE
REDUCTION RATIO
21.2x
SCALES AS SHOWN
DEPARTMENT OF MAIN ROADS N.S.W.
M.R.152 SHIRE OF MACLEAN
McFARLANE BRIDGE OVER THE CLARENCE RIVER
44 km NORTH EAST OF GRAFTON
REPAIR AND WIDENING OF SPANS 12 AND 13
FILE Nº 274-1100
Nº OF SHEETS 4
SHEET Nº 2
Reg. Nº 0152 274 BC 1209



REDUCTION RATIO
21.2x

DEPARTMENT OF MAIN ROADS N.S.W.
MR.152 SHIRE OF MACLEAN
M^C FARLANE BRIDGE OVER THE CLARENCE RIVER
44 km NORTH EAST OF GRAFTON
REPAIR AND WIDENING OF SPANS 12 AND 13.

FILE Nº	Nº OF SHEETS	SHEET Nº
274 1100	4	1

Reg. Nº 0152 274 BC 1209

THE McFARLANE BRIDGE
Technology and histroy

Movable span bridges in New South Wales

The two regions of New South Wales with the greatest number of movable span bridges are the Murray-Darling Basin and the North Coast. Their respective navigable rivers became the principal "highways" for travel, trade and commerce during the second half of the colonial period and lingered on until after World War I, an active, though steadily declining period of nearly eighty years.

Movable span bridges with low-level approaches were the cheapest solution for sharing the river crossings with the River Trade on the Murray-Darling-Murrumbidgee Rivers and the North Coast Shipping Trade from the Hunter River to the Tweed River, and the increasingly busy road networks.

There have been six basic types of movable span bridges, worldwide,

Pontoon bridges are a series of pontoons tied end to end with all but 2 or 3 firmly moored. The non-moored pontoons can be floated out of place so as to provide a passageway for any water craft. Although a wide passageway could be achieved, there were practical limits. However, headroom for tall masts or funnels is unlimited. (Echuca 1858)

Sliding or traversing bridges have part of their structure built on top of one of the approaches with a shorter extension over the passageway so as to be in balance. The section on the approach rests on rollers on a track such that the whole unit can be drawn horizontally backwards on the approach so that the extension clears the passageway. Limited width of opening but unlimited headroom. (Dunmore 1864)

Transporter bridges have a large overhead structure spanning full width of the waterway. A carriage, suspended from a mobile trolley running along the underside of the bridge, moves to and fro with road and pedestrian traffic. Plenty of passageway width but practical limits on headroom may restrict some tall-masted ships.
(No transporter bridges were built in Australia).

Swing bridges rest on a central pier and spin about its vertical axis. Two passageways of moderate width can be achieved and headroom is unlimited. However, the pivot pier may be in the middle of the deepest channel with less depth each side. A problem in times of low flows. (Hay 1874)

On the Lower Clarence, the first bridge across the Coldstream River was a swing bridge.

Bascule bridges have their movable spans hinged at one end and some mechanism draws the span from the closed horizontal position into a near vertical open position. Wide passageways can be achieved, there is unlimited headroom in the open position and the main pier can be located on the edge of the deepest channel.
(Darlington Point 1905)

The 1906 McFarlane Bridge at Maclean and the1905 Glebe Bridge on the Richmond River at Coraki, are curved-track bascule bridges, as seen here.

Lift bridges are characterised by the permanently horizontal span which is raised/lifted to the desired height through the action of the counterweights moving downwards, contrary to the upwards opening movement, as shown.

Wide passageways can be achieved and the main piers can be located on the edges of the deepest channel. However, headroom can be a problem in times of high water. (Swan Hill 1896)

On the Lower Clarence the 1966 Harwood Bridge is a lift bridge.

Pontoon, sliding and transporter bridges are operationally poor and have limited traffic capacity such that very few have been built, although, pontoon bridges have been widely used in temporary situations, particularly by the military.

Swing, bascule and lift bridges are the most common movable span bridges and appear in a great many variations, particularly in industrial countries with many navigable rivers/canals such as in the USA, Europe and Gt Britain. The combination of site details and bridge characteristics determines which bridge type is used. They are operationally quick and can cope with most road traffic demands except in peak hours.

Despite its feature of limited headroom, the lift bridge has proved to be the most common movable span bridge worldwide, including Australia.

The eminent Public Works bridge engineer, Percy Allan, summarised the advantages of lift bridges thus (*Lift bridge over the Murray River at Swan Hill*, Engg Section of Royal Society NSW, November 18, 1896),

- Economy
- Uninterrupted headway unnecessary in the absence of tall masted/funneled vessels
- Maximum headway only required in times of high water hence partial lifts
- Narrow main channels make central pivot piers objectionable.

Curved-track bascule bridges in New South Wales

Curved-track bascule bridges have a distinctive feature. The lift tower incorporates an approach span which supports two curved tracks each of which guides a roller counterweight. As the bascule span moves, up or down, the counterweights move along the tracks contrary to the span movement, continuously losing or gaining height, thereby ensuring balanced, low-effort conditions throughout the whole operation, a fundamental aspect of bascule bridges. The curved track was a sophisticated solution for maintaining continuous balance. Its origin in 18th century France, the mathematics for the curved track and the technical details are explained in the attached paper by Fraser and Deakin.

When the design reached the USA in the 1890s there were articles about this new style in *The Engineering Record* and *The Railroad Gazette*. Both journals were available to engineers in the Roads and Bridges Branch, NSW Public Works Department and one of its leading designers, Harvey Dare (see earlier bio-sketch), recognised its merits for use on navigable rivers in New South Wales. His first design was a timber structure over the Wilson River at Telegraph Point (1902). Except for another timber example at Swansea (1909), all subsequent bridges were steel from the same design, at Coraki (1905), Darlington Point (1905), Maclean (1906), Kyalite (1912), Carrathool (1924) and Cooks River (1927) as shown in the attached drawings for the McFarlane Bridge at Maclean. There was also a heavier steel example in 1925 for the Botany Railway over the Alexandra Canal (Shea's Creek), Mascot.

With only three complete bridges of this type existing (Coraki, Maclean, Carrathool plus the reconstructed tower in a park in Darlington Point), the McFarlane Bridge at Maclean is a fine representative example.

History of the McFarlane Bridge

This summary is based on information supplied by the Maclean District Historical Society Inc.

Vehicular ferries were the first method for crossing the Clarence River and its many tributaries, 19 in all just before the McFarlane Bridge was opened in 1906. One of these ferries was across the South Arm at Maclean on the upstream (south-east) side of the new bridge, see plan B.

From 1901 to 1906 the *Clarence River Advocate* published many progress reports, some of which are summarised s follows.

May 31, 1901 The Maclean and District Progress Association noted the inadequacy of the hand-operated ferry between Maclean and Woodford Island even though there were plans to install an oil engine. There had been a population increase at both locations and the quarry workers from Angourie had recently moved to the Ilarwill quarry on Woodford Island to supply rocks for the breakwater at Yamba. The Association resolved to seek a bridge.

Sept 27, 1901	Maclean Municipal Council resolved to apply to the Minister for Works for a bridge which would need to pass shipping.
Oct 15, 1901	Mr J McFarlane, Member for Clarence, had asked the Minister for Works to send a boring team to the site and check the depth of rock across the South Arm.
Jan 3, 1902	Minister for Works approved construction of a bridge at £15,000. Survey and Preliminary Report by Resident Engineer F S Murray. The boring plant arrived and was being used to test the river foundations.
May 26, 1903	Plans for the bridge on display at the Maclean Court House. Long article describing the low-level bridge and its bascule span, otherwise the whole bridge would have to be at a greater height to permit passage of river craft. There would extra expense and heavy approaches.
Jul 31, 1903	Tenders received from 6 contractors between £11.732 and £14,005, the lowest was from Mountney and Co., Pyrmont.
Oct 9, 1903	First suggestion of naming the structure the McFarlane Bridge.
Oct 16, 1903	Acceptance of Mountey's tender with a construction period of 78 weeks. The firm was building the same type of bridge at Coraki.
Oct 20, 1903	James Marsland, Mountney's representative arrived in Maclean and began preliminary steps for the erection of the bridge. Ironwork to be manufactured in NSW, fitted together in Sydney, dismantled and shipped to Maclean.
Mar 25, 1904	Long report on the turning of the first sod and the luncheon.
Apr 22, 1904	Mountney had begun work at Coraki first.
May 10, 1904	Ironwork, manufactured by the Government, had been delivered (*to Pyrmont? See Aug 26 and Dec 28*).
May 31, 1904	Work on the approaches started, pile driving gear had arrived.
Jun 10, 1904	Pile driving gear in position.
Jun 17, 1904	Long article about the ceremony of driving the first pile by John McFarlane MLA. So that the bridge would not block the South Arm, it

had to have an opening span. The bridge will be named the McFarlane Bridge.

Driving the first pile, 15 June 1904.

Jul 15, 1904 Pile driving completed (*but not the iron cylinder piles for the bascule span*).

Aug 26, 1904 Ironwork arrived on the *S S Augusta*).

Sept 27, 1904 Work in abeyance due to pushing on with the Coraki Bridge.

Dec 20, 1904 Problems and delays with driving the iron cylinder piles (*for the bascule span*).

Dec 28, 1904 *S S Augusta* arrived with tower ironwork.

Mar 28, 1905 Plant arriving from Coraki (*which is almost finished*).

Apr 21, 1905 Delays due to river bed material being different to the contract details.

May 28, 1905 Work continuing on the two iron cylinder piles.

Dec 15, 1905 Cylinders for tower completed, towers erected. Thoughts turn to the opening ceremony.

Feb 23, 1906 Meeting to consider the opening ceremony.

Feb 27, 1906 Long report about that meeting.

Mar 2, 1906 Opening initially set for 19 March but "last minute" delays due to finishing touches.

Apr 10, 1906 Report on Opening Ceremony yesterday (*April 9*), photo next page.

McFarlane Bridge Opening Day, 9 April 1906.

Also, there are three photocopies of articles from the *Daily Examiner* attached.

John McFarlane MLA

John McFarlane (portrait following) was born in the Hunter River district on 26 January 1854, the second son of John and Mary (nee Stuart). John, Sen., came to the colony from the Isle of Mull by the *British King* and Mary with her parents on the *George Fyfe* in 1840. Married in 1848, they were typical of the many free settlers brought out as migrants from Scotland in the 1830s and 1840s, and who formed the backbone of the pioneers of the northern coastal rivers of NSW. The father was teacher and the family moved to the Lower Clarence in 1861 where a 58-acre farm was purchased near the junction of Swan Creek with the Clarence River.

John. Jun,. was educated both at his father's schools and by his private tuition. After leaving school he worked on the farm, took up land of his own and finally went to Sydney in 1884 to start in business as an agent for maize, timber and general produce (*much like the contemporary, successful John See*). In 1887 he became the Member for Clarence and retained the seat until his death in 1915. He was a good politician, visiting the electorate frequently which at that time meant travelling by sea to and from Sydney.

He strongly supported the need and lobbied successfully for the bridge across the South Arm at Maclean hence it being named after him.

John McFarlane (1854-1915)

SATURDAY, MARCH 24.

SHIPPING.

Kyogle has been bar-bound since Wed-
y, owing to the rough sea on the bar.
Nymboida, that took the place of the
tina this trip, arrived off the bar on
day, but was unable to cross in. The
ers will probably cross to-day, as the
is to sound the bar this forenoon.
sailing vessel Edward is unable to
out, and the Pelotas is outside wait-
come in. The sea on the coast has
the roughest experienced for many
though the wind is not high. A
must, however, have been blowing
e coast. The Kyogle's passengers re-
l to Grafton, and proceeded to Syd-
a Glen Innes.

Member for the Clarence, accompan-
Mr. J. T. M'Kittrick, proceeded to
eads yesterday, with the view of in-
g Yamba channel. Mr. M'Farlane
s to Sydney to-day by the Kyogle.

engers outwards per Kallatina last
lay—Mesdames Vaughan, S. W.
: Misses M'Gregor, Francis, Beard,
d, Willmith, Jackson, E. Porter;
M. Myers, J. F. Cobcroft, R., Bul-
G. Bradshaw, W. H. Dunn, A. Dav-
Wright, H. Craig, M. Hodge, Skully,
mes, B. Howard, Brodrick, E. Pow-
Whaites, G. Shore, Pugh, A. Sel-
C. S. Kent: and 14 in the steerage.

rts Kyogle on Wednesday:—
ones, 080b. maize 5b. pumpkins,
butter, 86c. eggs, 56c. fruit, 3c. tal-
b. millet, 6c. poultry, 4b. skins, 1
78 hides, and sundries.

North Coast S.N. Co.'s new steamer
ah arrived on her maiden trip to
eed on Sunday afternoon. The Dur-
is an ideal vessel for the Tweed
being fast and easily handled. Cap-
air is in command.

Lady Beatrice went into Ashby dock
ursday, and her running has been
y the Young Dick.

s. Langley Brothers' new boat Coo-
rived on Saturday on her first trip
Tweed. She is the largest boat that
visited Murwillumbah. Captain
who is well known in the locality,
er, and there is a crew of 14. The
will probably made weekly trips to
ed.

MACLEAN SHOW.

attendance on the second day totalled
4000, the takings being £ 18s
onsiderably more than that of last
Altogether the show was superior to
of last year and many of those of
years, and the attendance demon-
d the popularity of the lower river
ons. The President and the com-
emen did all in their power to please
ublic and visitors, and in this they
ded remarkably well. A Singer sew-
achine was offered as a prize for
ng the weight of a fat ox, which
946lbs. Only one person guessed
act weight, Constable Clarke, of
n. Many others guessed 1lb. under,
hers 1lb. over the weight of the ani-
Throughout the whole proceedings
g occurred to in any way interfere
he success of the show, and the pub-
l competitors showed their apprecia-
the endeavours of the stewards and
to act conscientiously in making

CROWN LANDS.

The following applications have been lodg-
ed at the Grafton Lands Office:—

John Alexander Stuart, Tyndale, o.c.p.
of 160 acres, county Clarence, parish of
Tyndale, commencing at a point 10 chains
east of the north-east corner of portion
99, and bounded thence east 40 chains,
thence north 40 chains, thence west and
south to the point of commencement. With-
in Taloumbi resumed area. Deposit paid
£16, survey fee £6.

John Alexander Stuart, Tyndale, c.l. of
480 acres, county Clarence, parish of Tyn-
dale, commencing at the north-west corner
of applicant's conditional purchase of same
date, thence north 40 chains, thence
east, south, and west to water reserve
39941, thence north, west and south by
the boundaries of that reserve, and again
west to the south-east corner of appli-
cant's c.p., thence north and west to start-
ing point. Deposit paid £4, survey fee
£7 0s 8d. Within Taloumbi resumed area.

Alexander Salmon M'Donald, Casino
road, o.c.p. of 170 acres, county Clarence,
parish of Stuart, adjoining the north bound-
dary of portion 31, and extending to
Sportsman's Creek. Within Southgate and
Blake's Creek resumed area. Deposit paid
£17, survey fee £6 2s 6d.

Eliza Murial Collett, Ulmarra, c.l. of
200 acres, county Clarence, parish of
Maryvale, adjoining the north boundaries
of portions 56 and 57, and extending
north. Deposit paid 33s 4d, survey fee £4
17s 6d.

LAND BOARD SITTINGS.

The Local Land Board held a sitting at
Coff's Harbour last week. The members of
the Board were Messrs. W. Freeman (Chair-
man), E. J. Raymond, and F. W. Lane.

The following c.p.'s and c.l.'s were con-
firmed:—James Reedy, 120a., Bonville, ap-
praised value 20s per acre; R. Reedy, 60a.,
Bonville; applicant granted permission to
reside on his brother's c.p.; H. R. Hosch-
ke, 300a., Coff; A. A. Moran, 132½a., Bon-
ville; W. H. Archer, 60a., Bonville; S.
Hermann, 40a., Bonville; J. Thompson,
235a., Bonville; D. L. M'Kinnon, 40a.,
Coff; C. Ferrett, 55a., Coff, applicant
granted permission to reside on c.p. 99/2,
on condition that within three years im-
provements to the value of £40 shall have
been effected, and within five years £60.

W. S. Cook, c.p. of 70a., Bonville, with-
drawal permitted.

H. F. Mason, 171a., homestead selection.
The Board found that conditions of re-
sidence had not been fulfilled for a consid-
erable time, and under the circumstances
could not grant permission to cease resid-
ing on the land for a further period of six
months. Waiver of forfeiture was recom-
mended, subject to the conditions that by
10th December next improvements be effect-
ed to the value of £171, and that by 30th
June next selector shall enter into full re-
sidence.

P. T. Peachey was granted suspension of
conditions of residence for six months.
Crown improvements valued at £2.

W. Geddes, 100 and 100a., Coff. Disal-
lowed, land not available.

C.P.'s and c.l.'s ordered for survey—J.
Martin, 100 and 50a., Coff; H. Higgins,
40 and 60a., Bonville.

H. E. Kasch, Crown improvements valu-
ed at 20s.

Kate M'Cann (now Mrs. Hanley), 66a.,
capital value appraised at 15s per acre.

N. Glass, special lease of 4a., Coff. Post-
poned. Another special lease application
was withdrawn.

AT MACLEAN.

List of cases to be dealt with by the
Chairman sitting alone at Maclean on
27th March. Approval or otherwise:—
Stephen Morley, Thomas Butcher. Reduc-
tion balance purchase money, etc.—Honora
Cullen. Confirmation or otherwise—Angus
Sutherland, H. E. Forester, G. Carter,
Robert Sutherland. Fulfilment of condi-
tions—John W. Smith. Issue of certifi-
cate—W. S. Artner, Nicholas J. Johns.

To be dealt with by the Land Board,
March 28th, at Maclean:—Approval or
otherwise—J. C. Kable, J. A. Blanch,
Francis H. Schwonberg. Appraisement of
value—F. J. Bathgate, R. E. Powell, R.
M'Aulay, Angus Mackenzie. Confirmation
or otherwise—D. Cook, J. Cooney, T. J.
Smith, J. Connolly, W. J. Essex, J.
Loughman, jun. Appraisement Crown
lands—Gaven B. M'Clymont. Value of
land resumed—A. M'Donald. Confirmation
or otherwise—J. D. M. Waugh, George
Kater, and S. J. A. Waugh. Allotment of
area—W. N. R. S. Waugh, J. B. Fennessy.

SOUTH ARM BRIDGE.

This fine structure is approaching comple-
tion, and was an object of special attrac-
tion to the visitors to the Maclean show
this week. It is undoubtedly the finest
structure of its kind in the district, though
not the most costly. The decking is now
being placed on the end next Woodford Is-
land, and it can be actually crossed by
pedestrians. The draw was worked on
Thursday to admit the passage of the
steamers to the show ground, and it ap-
peared to be operated without difficulty.
This structure not only provides a cross-
ing for residents of the lower portion of
the island to the mainland, but is an im-
portant link of connection on the road
from the Lower Clarence to Grafton. Per-
sons so travelling may either cross at the
Bluff Point Ferry below Lawrence or at
the Southgate punt. The punt that has
done service at the place now spanned by
the bridge conveyed a considerable amount
of traffic over the Arm. On Wednesday
last Mr. Mullins, representative on the
work for the contractors, Messrs. Mount-
ney and Co., invited the Members for the
Clarence and Raleigh to cross the new
bridge on foot. They accordingly went
over, accompanied by a number of people,
and on returning to the contractor's office,
Mr. Briner, M.L.A., in proposing the
health of the Member for the Clarence,
complimented the residents on the erection
of so magnificent a structure. He said
that it was solely due to the efforts of
Mr. M'Farlane that the briuge had been
obtained. Personally he claimed no credit
for the accomplishment of so fine a bridge,
which he regarded as a great district im-
provement. Their Member had displayed
considerable energy in extracting so much
money out of the Government. The most
harmonious feeling existed between their
Member and himself, and they had mutual-
ly assisted each other in obtaining for the
district what it required.

Mr. M'Farlane, in reply, referred to
the delay in opening the bridge, which
was due to a large extent by the
wet weather. He was convinced that the en-
thusiasm of the people was so great that
they would not mind the little delay that
had arisen, and the opening would be an
accomplished fact within a few weeks. He
also referred to the harmonious manner
that he and Mr. Briner had worked for the
benefit of both their electorates, and it
would be detrimental to each if that har-
mony did not exist. The construction of
the bridge did not affect Maclean and
Woodford Island alone, for he regarded it
as a national work, which benefited the
travelling public. He spoke of other brid-
ges in contemplation, including the Oyster
Channel and Upper Coldstream, and any
assistance he could give in the construc-
tion of these he would be most willing to
give. He concluded by proposing the
health of the contractors, coupling with it
the name of the representative, Mr. Mul-
lins. He was personally acquainted with
the firm, who had the reputation of carry-
ing out their work in a satisfactory man-
ner.

Mr. Mullins suitably responded to the

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OPENING McFARLANE BRIDGE.

The fine substantial structure that spans the South Arm at Maclean was formally opened yesterday by Mrs. J. M'Farlane, wife of the Member for the Clarence, in whose honor the bridge was named. The event excited a good deal of local interest, and a large number assembled to take part in the ceremony. The Member for the Clarence, together with Mrs. M'Farlane, arrived by the Kallatina in the morning, and a number of visitors were present, representing most parts of the district. A committee, with Mr. W. J. Dunnet as secretary, attended to details, and these were satisfactorily carried out, the Mayor of Maclean and ex-Mayor J. M. Kelly, who marshalled the procession, rendering valuable assistance. Proceedings commenced with a procession, which started from the Caledonian Hall, and this was headed by two Highland pipers and the local band playing appropriate selections. Next followed the Member for the Clarence, accompanied by the Mayors of Maclean and Grafton, followed by the aldermen of these boroughs. Next came the members of the local Lodge of Oddfellows, preceded by the beautiful banner of the Star of the East Lodge. Members of the Guild were next in order, then a lengthy procession of school children, civilians taking up the rear, while scores lined the footways in the route of the procession. A half-holiday was granted the school children within a radius of ten miles of Maclean. On arrival at the point of the street where the approach leads to the bridge, a halt was made, and here there was a display of bunting indicating the centre of attraction. Flags were also displayed at various conspicuous places along the route.

The Mayor welcomed the Member and Mrs. M'Farlane, and said they were pleased to see them both. It was mainly owing to the efforts of the former that they succeeded in getting the bridge.

The Member thanked the Mayor for his flattering remarks, and said it gave him infinite pleasure to meet so large a number of friends, with whom he had been politically associated for 18 years. He was very pleased to see such an important work carried out, and he felt proud of the magnificent structure that connected Woodford Island with the mainland. The presence of so many people from various parts of the district showed that the bridge was of more than local interest, and one that affected the whole district. He conveyed the congratulations of the Minister for Works, who was unavoidably absent owing to attending a conference of Premiers. Mr. Brinner was also unavoidably absent, but had sent a telegram wishing the function success. There were many who doubted that the bridge would be constructed, but it was now an accomplished fact. There were many difficulties to encounter in getting it built, of which the Ministerial sanction was not the worst. There was a depleted Treasury, and some trouble in getting loan money. It was with the latter the bridge was constructed. But once a tender was accepted, he had no further doubt of the erection, as personally he knew the capability of the firm of Messrs. Mountney and Co. to carry out the contract. The feature of the Clarence district was the great number of channels, arms and tributaries, and while these added enormously to the general prosperity, they increased the difficulties of travel. There were 19 punts on the Clarence, and the crossing by these old methods was tedious to the travelling public, and they were being replaced by bridges as far as practicable. It would be some time yet before the punts were entirely dispensed with, but wherever the traffic warranted bridges would be erected. He regarded the pulling over a river by punt rope was a system that should be obsolete, and a more up-to-date method introduced. A bridge that needed to be constructed was one over the Oyster Channel, and one over the Coldstream, and he would do his best in assisting the Member for Raleigh to have these built. There were parts of the Upper Clarence that should be bridged also. He confessed that in advocating these works he was liable to the imputation of being termed a roads and bridges member, and the Sydney press, as well as metropolitan members, used this imputation freely. [illegible] for the good of the country, they would be almost inoperative unless facilities were given for settling the land. There were parts of the State where people could not settle on the land because the Government did not give proper facilities to market. The members and press should not ridicule those who endeavoured to give facilities to the men on the land. With reference to Local Government, he had strenuously opposed it, and did not regret doing so, notwithstanding that he had been censured by the Premier for his opposition. It would mean a heavy extra tax on the country, and would mean that some of the most important works would not be carried out at all. He was pleased to meet some of the electors who formerly supported him, and took the opportunity of explaining why he decided to represent the Clarence. The old electorate was equally divided, and no matter which part he selected, he must abandon the other. He consulted a number of his friends, and it was agreed that he should contest the Clarence. But though he had done so, he did not forget his old friends, and would assist them as much as he could in getting public works carried out. There were some who advocated the levying of tolls on bridges, but he had no sympathy with this semi-barbaric method. A punt or bridge was part of a highway, and there was as much justification in charging toll on a road as on a bridge or punt.

The procession was then reformed, and proceeded down the approach. At the bridge proper a blue ribbon barred further progress, and here the christening ceremony was performed by Mrs. M'Farlane, who broke a bottle of wine on the decking, three cheers following the demolition of the bottle. The Member, then severing the ribbon, declared the bridge duly open, and repeated the ceremony at the centre of the structure. The bridge was then crossed, and a landing effected on Woodford Island. The return was accomplished with some difficulty, owing to the crowd surging forward in the opposite direction. On reaching the mainland, the show ground was entered, where the juveniles indulged in various sports. The Mayor, Member, with some visitors and representative citizens, repaired to the luncheon pavilion, where the Mayor of Maclean presided. After the loyal toast had been honoured, the Mayor proposed "The Guest," and referred to the manner he had attended to the requirements of the electorate during the long period he was member. He was prompt in replying at all times to any matter that was referred to him, and so long as that bridge remained it would be a tribute to his memory.

Mr. J. M. Kelly and Rev. Father Walsh supported the toast, the latter in a humorous speech referring to the bridge as a connecting link between the Member's past and present electorates. He also referred to Mr. M'Farlane's satisfactory representation for 18 years, and the bridge would fittingly perpetuate his memory. He trusted that both Mr. and Mrs. M'Farlane would live many happy years.

Mr. D. Shearer expressed pleasure at being one of Mr. M'Farlane's constituents. He had known Mr. and Mrs. M'Farlane many years, and as Returning Officer had declared the former elected no less than six times. He spoke of the progress the district had made since he represented it in Parliament.

Mr. Holden, Mr. P. J. Maher (representing the Harwood Progress Association), and Mr. J. G. Phillips (Returning Officer at Grafton and secretary to the Grafton Hospital) testified to the member's promptness and assiduity in dealing with public matters.

The Member, in responding, said it was a pleasure for them both to come to the district where they received uniform kindness. Though he did his best for the electorate, they could understand that it was impossible to get all requirements attended to. He thanked Father Walsh and the other speakers for their kind expressions.

Mr. M'Farlane proposed "Prosperity to the District." He became acquainted with it in 1861, and though he had visited all the other States except Tasmania, he had seen nothing to compare with the North Coast of N.S. Wales. He deprecated any rivalry between the rivers, and referred to a little friction that occurred over the North Coast railway. This would benefit producers on the smaller rivers especially, and the settlers on the intermediate coun- [illegible] would be the means of placing th[e] [illegible] in homes. Though the Grafton-Cas[ino] way had been handed over only [a few] months, the returns were increasin[g and] had astonished many, including th[e Rail]way Commissioners. He believed t[he tour]ists who are to arrive on Saturday [would] be astonished at the richness of th[e coun]try, and would after their return [be mis]sionaries in the interests of the [North] Coast.

The toast was suitably acknowle[dged by] Messrs. R. J. M'Donald and A. H. [illegible]

Mr. P. H. Gallagher proposed "T[he Con]tractors, Messrs. Mountney an[d Co.,"] coupling with it the names of the [super]visors, Messrs. Mullens and Green.

Both these gentlemen duly replie[d.]

Ald. Schwonberg proposed "Th[e Visit]ors," which was responded to by t[he May]or of Grafton, Ald. Trent, Maxted, and Mr. J. G. Phillips, Council Cler[k, who] expressed pleasure at having the p[leasure] of taking part in the celebratio[n, and] trusted the time was not far dista[nt when] the opening of a bridge across the [Clarence] at Grafton would be celebrated in [like] manner. The services of Messrs. [illegible] and Reed in connection with th[e] works at Grafton was also acknov[ledged.]

Mr. C. W. Rayner proposed "The [Press,"] which was acknowledged by represe[ntatives] of the "Examiner" and "Advocate[."]

The toast of "The Chairman" [illegible] Member, and Ald. Powell's reply, [closed] the proceedings.

The Lady Beatrice, with the Graft[on con]tingent of visitors, then proceeded [to] the opening in the bridge, a large [number] of vehicles meanwhile awaiting the [complet]ing of the lift to its position to enab[le them] to cross.

The functions on the show gro[und in] connection with the bridge opening [continued] as darkness wore on. Everything [went] off most successfully. Much interes[t was] centred in the games and sports of [the ju]veniles.

A description of the bridge has [already] appeared in our columns.

LOWER CLARENCE CALEDONIAN SO[CIETY]

The annual meeting of members was [held on] Friday evening.

The receipts for the year, outside the [gather]ing on New Year's Day, totalled £120 [illegible] the principal items being—rents £43 [illegible] donations £10 2s, entertainments £2[illegible] disbursements totalled £126, including a [bal]ance from the previous year of £63 8s [illegible] Society's assets put down at £1170 [illegible] liabilities at £880. The receipts of th[e gath]ering on New Year's Day amounted t[o £285] 4s 3d, and the disbursements to £256 [illegible] leaving a credit balance of £29 2s 10d[.]

The following were elected officers a[nd com]mittee for the ensuing year:—President, [illegible] Lobban; V.P's., Messrs. D. T. Burt, [illegible] and W. Nicholson; Treasurer, Mr. J. [illegible]kay; Secretary, Mr. E. D. Munro; Co[mmittee,] Messrs. J. and A. M'Millan, J. Shaw, [illegible] W. M'Swan, D. and G. Gregor, D. Math[eson,] Joyce, G. Austin, W. J. Dunnet, C. D. [illegible] A. Smith, Donald M'Donald, C. Bathg[ate,] M'Leod, J. M'Lachlan, M. M'Swan, W. [illegible] M. M'Kinnon, and H. R. H. Husband.

Votes of thanks were accorded tho[se who] assisted at the late gathering.

It was a recommendation to the [incoming] committee that a gathering be held ei[ther at] Grafton or Maclean on May 24th or J[une].

The sailing race prize was passed f[or pay]ment.

The protest against P. Kenny in the [illegible] event was entertained, and the prize [was] awarded to the next competitor.

GRANTS FOR PUBLIC PURPOS[ES]

The member for the Clarence has bee[n advised] that the following grants have been [made to] the institutions named:—Grafton [Hospital] £200, Grafton Benevolent Asylum £2[illegible] ton Water Brigade £15, South Graft[on Fire] Brigade £10. The Member, who rece[ived the] above information after his arrival a[t Maclean] yesterday, immediately wired back t[o say] that the Hospital grant of £200 w[as inade]quate to meet requirements, and ur[ging that] the amount be increased to £300 in a[ccordance] with a promise made by the Pre[mier some] months ago.

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Laurie, the clerk of the ring yelling out to round up for the hunter jump, and the bellman demanding a big roll-up to-night to Kate Howarde. Thus everything went merrily along. The horses were splendid, the ladies rode like witches, the trotting was superb; did you notice the driving action of that grey? Even the costermongers made a fine show, and the old chap richly deserved his prize and applause for his make-up of rope harness and bamboo and batten shafts. Everybody was working, active, smiling, courteous; the whole concern seemed to be a mutual admiration society, and they certainly did it to some purpose. There was no dissentient voice, all a chorus of congratulation to our neighbours; and I came home with a sweet taste in my mouth.

DISTRICT NEWS.

ULMARRA, Friday.

U.P. and A. SOCIETY.—A well-attended committee meeting was held on Thursday, Mr. T. Glissan (President) in the chair. Mr. M'Farlane, M.P., thanked the committee for invitation to attend Show and would accept if at all possible. He had interviewed the Minister re supplying a steam launch to tow the Ulmarra-Southgate punt on that day, and believed he would succeed in getting one. Gerard and Co. and C. Pullen agreed to run their steamers, and Mr. Shore was to be written to asking him to put the Atalanta on that day. The President, Messrs. J. B. Carlton, Jos. Northcott, S. Mawhinney, sen., A. G. Bailey, and John Forsythe, sen., were appointed to entertain visitors. The hotel booth is to have a guarantee of 50 for luncheon at 2/6 per head. Messrs. G. Kelly, W. Morris, and J. Chisholm will attend to guessing competition, and the assistance of two ladies will be solicited, the prizes to be 2/2/0 and 10/6. It was unanimously decided on the motion of Mr. James Carlton, that the President open the Show. No vehicles for exhibition will be allowed on the ground other than those entered for prizes. Messrs. Morris, Taylor, and M'Lair donated a prize of 30/ for the wo... turn out. A prize of £1 1s for first and 10/6 for second was allotted for a pen of 3 heifers, 1 year and under 2. The full schedule will appear in next issue. The sale of privileges, booth, and refreshment stalls will be held on Tuesday, not Wednesday, as stated in last advertisement.

REV. MR. AND MRS. DIXON.—The Rev. F. and Mrs. Dixon have become so endeared to many people that they are not to be allowed to depart without some token of appreciation; and it has been determined to tender them a farewell tea and public meeting next Wednesday. We are informed that several musical items will be rendered.

The Y.P.M.I. met on Thursday in the Temperance Hall, Mr. Mulholland, V.P., occupied the chair, and said they had gathered together that night to show the Society's appreciation of the services of the Rev. F. Dixon. Later in the evening he called on the Mayor, who said he was glad he had been invited, and was more than pleased to see such a number present to honour the Rev. F. Dixon, who had worked so well for the Society. The gift which he now presented was a handsome set of carvers in case, with an engraved plate bearing "Presented to the Rev. F. Dixon by the Y.P.M.I. Society, Ulmarra." He wished Mr. and Mrs. Dixon and family prosperity and happiness in their new home. The Rev. R. Cordiner gave good advice to the Young People, and praised Mr. Dixon's work; and as a friend and upright man there was none better. He had worked hard for this Society, and was glad his labours had been appreciated. Messrs. E. Cameron, J.P., J. Retallick, J.P., Jos. Northcott, J.P., A. G. Bailey, P. Thompson, C. Turnbull (secretary) also testified to the good and energetic labours of the Rev. F. Dixon. The guest, in reply, thanked them heartily for the present they had made him. Anything he had done was due to the help he had received, especially from the young people, and he felt that he had not done enough. They had some pleasant times together, and much good work had been done. He trusted that it would still further prosper. He and Mrs. Dixon would treasure the gift as long as they lived. He had learned much in his connection with the Society, and felt sure others had done so also. During the evening Miss Yoole played an overture; songs were given by Misses Elvina Browne, Effie Turnbull, M'Intosh, Messrs. Retallick, B. Yoole, P. Thompson (encore), Stuart M'Lachlan, and a violin solo by Mr. C. Cameron, all receiving approbation. Refreshments were partaken of, and the evening's entertainment concluded with "Auld Lang Syne," and thanks to the chairman (the Mayor), proposed by Rev. R. Cordiner, who extolled the energy of Mr. Glissan in connection with Ulmarra affairs.

The Methodist Church hold harvest thanksgiving services to-morrow. The Rev. F. Dixon will preach in the morning, and Mr. Roger Page at night. This will be Mr. Page's farewell at Ulmarra.

Last January it was our privilege to congratulate Mr. Clarence H. Northcott, on the success he achieved in the University examinations of December last. Now we have the pleasing duty of again congratulating that young gentleman. In the honours examination held a fortnight ago Mr. Northcott obtained first-class honours in both English History and Philosophy. He also obtained half of Professor Anderson's prize of £5 for proficiency in the work of the year in Philosophy, and was placed prox. acc. to Prof. Woods' prize for English History.

The Ulmarra Oddfellows and members of the School of Arts play a card tournament on Wednesday next.

MACLEAN, Friday.

A large number of people assembled to witness the turning of the first sod of the South Arm bridge on Thursday morning. The Mayor called upon Mr. M'Farlane, M.L.A., to perform the act, who afterwards expressed his pleasure at having the opportunity of being present to witness the commencement of the work, really which meant the expenditure of £12,000. The bridge would prove of great advantage to the public, and facilitate travelling. There were difficulties in the way of getting the work undertaken, but these had been overcome. Other works were very necessary for the district, such as the Oyster Channel crossing, which was estimated to cost £4600. Ministerial approval had been given, and the only obstacle now was the absence of funds. There was a large amount of traffic between Grafton and Yamba, and it would increase as soon as this crossing was provided. Another bridge was required over the South Arm at Brushgrove and over the Upper Cold stream, and they should really be sanctioned. When such facilities were given they would enhance the value of their properties.

Mr. Mountney (contractor), said he would employ all the local labour possible, and hoped to have the bridge ready for the next annual Show.

Mr. G. D. Clark, of Sydney, congratulated the people on the signs of progress, and was pleased to see a bridge was to be placed over the South Arm.

Luncheon was then partaken of in the Show-ground pavilion.

Responding to the toast of "The Parliament," Mr. M'Farlane spoke of the difficulty in financing in consequence of the drought, followed by the tightness of the money market, but withal much good work had been done. He favoured the construction of railways and harbours out of loan votes, because these works served those who followed us. A coalition Government would be better than the present working, with a third party, really in the minority, dominating the House. With the reduction of members the country would lose about 30 representatives, and the city only four, and he expressed himself as opposed to the proposed cutting up of the Clarence Electorate. He favoured the extension of both Grafton and The Clarence Electorates into Raleigh, without altering the boundary between these two electorates.

BRUSHGROVE, Friday.

The carving-up of the Clarence Electorate into two parts, giving us minority votes in Grafton and Raleigh, is by no means acceptable, and a public meeting is convened for Wednesday night to protest against the proposed boundaries, and it is hoped that electors will attend and give expression to their views. Whilst admitting the difficulties connected with re-arranging of electoral boundaries, we believe that a more equitable division can be made.

On Sunday evening Rev. Mr. Dixon made reference to the sad death of the wife of Rev. J. Harding, who was at one time stationed in Brushgrove.

Harvest services were held in the Methodist Church on Sunday. The minister conducted the morning service, when the edifice was crowded. The S. School prizes were given, and the preacher spoke highly of the self-denying work of both officers and teachers. Mr. R. Page preached to a large congregation at night, delivering an excellent discourse, and the choir rendered special anthems.

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Henry Harvey DARE

Harvey Dare (1867-1949) was one of Australia's foremost engineers of the late colonial period and the early 20th century. He was born in Goulburn, NSW but attended Sydney Grammar School. He received his engineering education at Sydney University's School of Engineering under Prof. W H Warren, graduating with a BE and University Medal in 1888, In 1894 he gained a second University Medal for his Master of Engineering. He assisted in Prof. Warren's extensive programme of testing most of the timber species of NSW for their engineering properties which proved so useful in the design of timber infrastructure such as the timber truss bridges. At age 20 he was an Assistant at the Sydney Observatory but in February 1889 he joined the New South Wales Department of Public Works. He became a specialist in the design and construction of bridges, water-supply schemes and dams.

By 1901, he had been associated with many major bridges under the direction of Percy Allan and E M de Burgh. In 1905 he developed the composite timber and steel truss that now bears his name, 27 of which were in service as at 2004 with six on the State Heritage Register. He and JJC Bradfield were closely involved in the preliminaries for the Sydney Harbour Bridge. He pioneered the use of a distinctive type of bascule bridge which had counterweighs moving down a curved track so as to maintain balance. By 1904 he was Assistant Engineer in charge of Design.

In 1910 he was transferred to rivers, water-supply and drainage as Principal Assistant Engineer to LAB Wade and was engaged in the preparations for the Murrumbidgee Irrigation Scheme including Burrenjuck Dam, now a National Engineering Landmark.

In 1911 he was appointed Engineer for Water-supply, Sewerage and Drainage and assumed responsibility for planning three dams of the Upper Nepean Scheme (Cordeaux, Avon and Nepean). He concluded his career with Public Works Department as Chief Engineer for National Works and Drainage.

With the establishment of the Water Conservation and Irrigation Commission in 1913 he was appointed Chief Engineer and then Commissioner in 1916 during which time he oversaw the completion of Burrenjuck Dam. In 1923 he represented NSW on the River Murray Commission.

He was prominent in professional bodies, receiving two Telford Premiums from the Inst. Civil Engrs., London and the Peter Nicol Russell Medal from the Inst. Engrs. Aust. He retired in May 1935 after 47 years in public service. He was one of Australia's outstanding civil engineers.

Curved Track Bascule Bridges: From Castle Drawbridge to Modern Applications

By Donald J. Fraser and Michael A. B. Deakin

Introduction

The wooden drawbridge was an important item of infrastructure for the entrances to castles (fig.1) and other types of fortifications from the medieval period (circa 1100) through the early nineteenth century (circa 1820). The bridge was of the simple trunnion type, pinned next to the castle entrance and raised by pulling on ropes attached to the outer end of the bridge (figure 2).

Somewhere inside the stone gate tower would have been a manually operated winch to which the draw ropes or chains were attached. Operation without any form of mechanical gearing or balancing of the weight of the bridge would have been difficult. Starting the lift against the full weight of the bridge would have especially been hard (although it became progressively easier the further the bridge was raised), and lowering could be hazardous with the bridge tending to run away, unless there was a braking system.

Simply adding a counterweight suspended vertically (figure 2) was no help because during raising, the counterweight quickly overcomes the bridge which slams into the tower, unless the winch is fitted with a brake, then there's the problem of how to push the bridge down. Balance was the key to success; hence the development of the bascule bridge, a drawbridge which is balanced throughout all stages of operation. Bascule comes from the old French word *bacule* which means see-saw or balance. French engineers made a significant contribution to solving this problem, one of which led to the curved track bascule bridge.

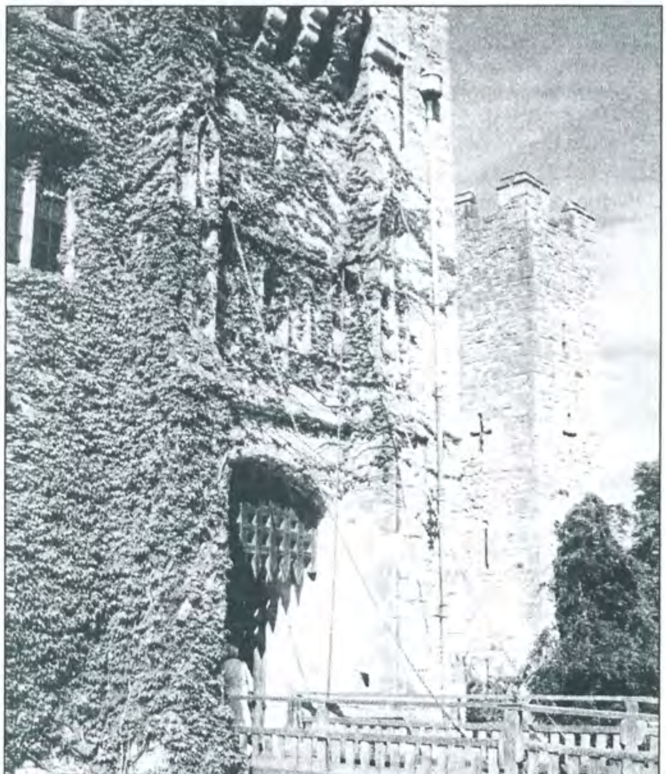


Figure 1. Medieval drawbridge

One of the earliest balanced bridges was indeed a see-saw (figure 3), generally known as the Dutch bascule bridge and still in use over canals in Holland and England. As the centre of gravity of the bridge rises and rotates towards the tower, the counterweight lowers and also rotates towards the tower. Modern versions are still being built (figure 4).

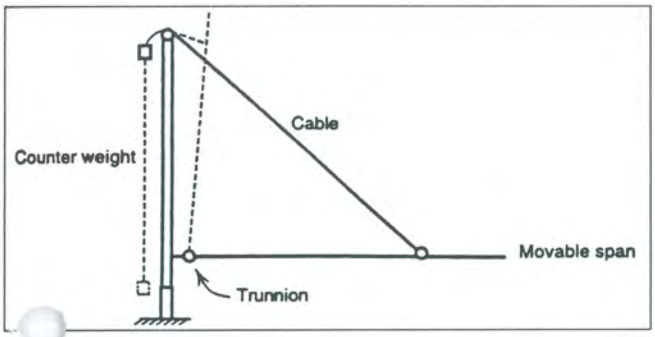


Figure 2. Simple trunnion bridge

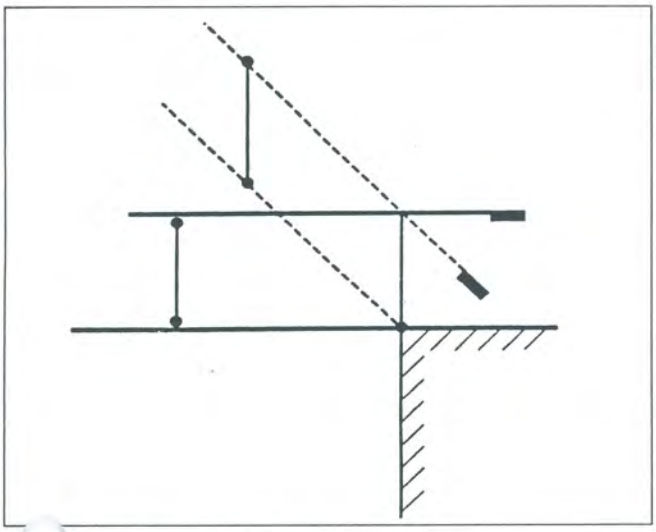


Figure 3. Basic trunnion bridge

The vertical counterweight also provided a solution (figure 5). An Australian engineer used a counterweight made from an inverted series of cast iron discs, the largest at the top down to the smallest at the bottom. Full weight is available to start the bridge rising but as the effort to continue the rise decreases, horizontal brackets pick off the most upper of the discs thereby decreasing the amount of counterweight, child's play with a child's toy. But the concept was used into the twentieth century. In their 1943 text book, Hool and Kinne[1] refer to this as a sectional counterweight, and they provide a graph showing that the abrupt change in counterweight as each disc is removed causes a series of fast-slow departures from a smooth operation.

In the early 1800s the French produced the more sophisticated solutions (figure 6) for keeping the counterweight constant but reducing its effort as the bridge rose.[2]

In figure 6 there are three pulleys, the one nearest the wall carries the constant counterweight Q, the middle one carries the bridge chain and the third is the operator's chain. The important detail is that the counterweight pulley is made in the form of a spiral so that as the bridge pulley rotates counterclockwise (the bridge rises and its resistance decreases), the spiral rotates with it so that its radius to the counterweight decreases. Hence its effort to raise the bridge decreases in balance with the bridge. The effort from the operator's chain is simply to overcome friction in the system.

Once again the concept was used in the twentieth century. Another example, in Hovey's book,[2] shows a bascule bridge with a constant counterweight moving vertically, but its pulley at the top of the tower has a spiral groove cut into a tapered drum which is keyed to the constant diameter drum for the bridge cable. Therefore, as the bridge rose and the counterweight dropped, the counterweight cable progressively wound onto a smaller diameter of the tapered drum so that its decreasing radius matched

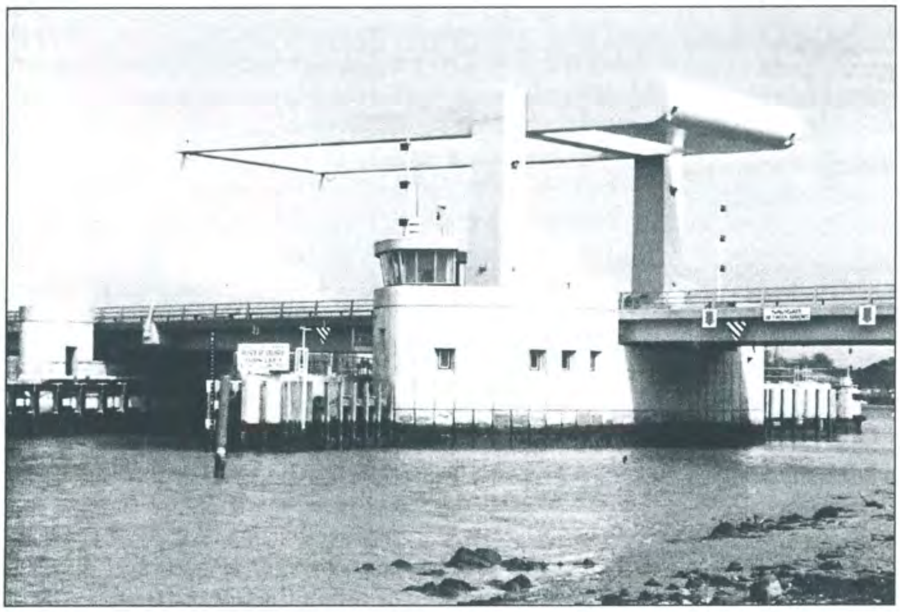
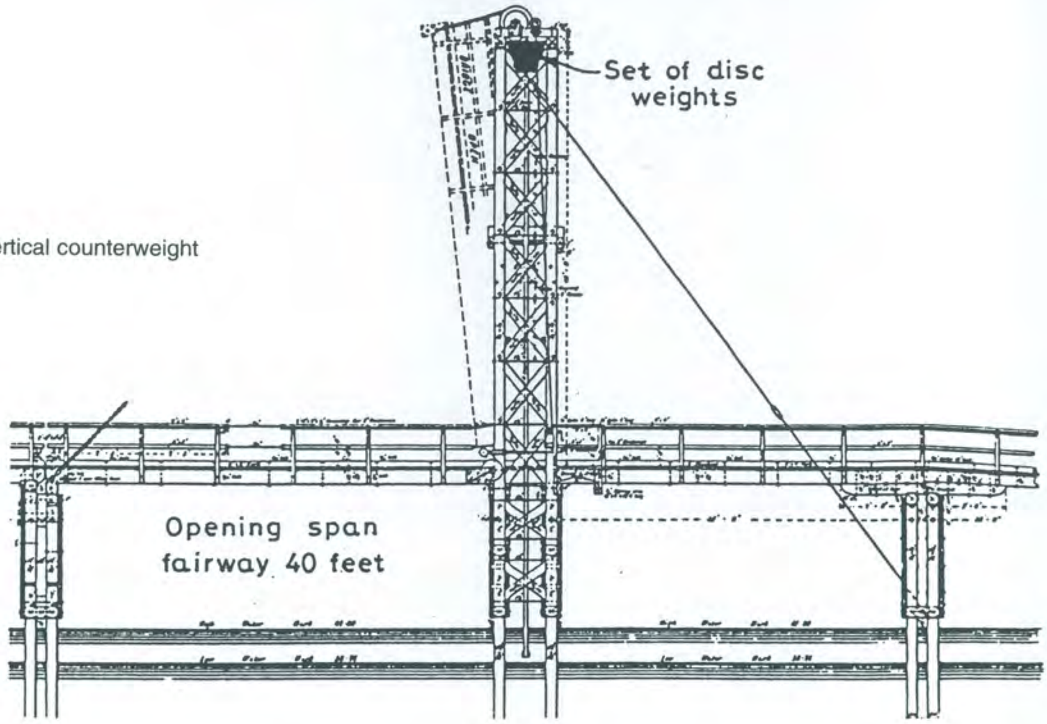
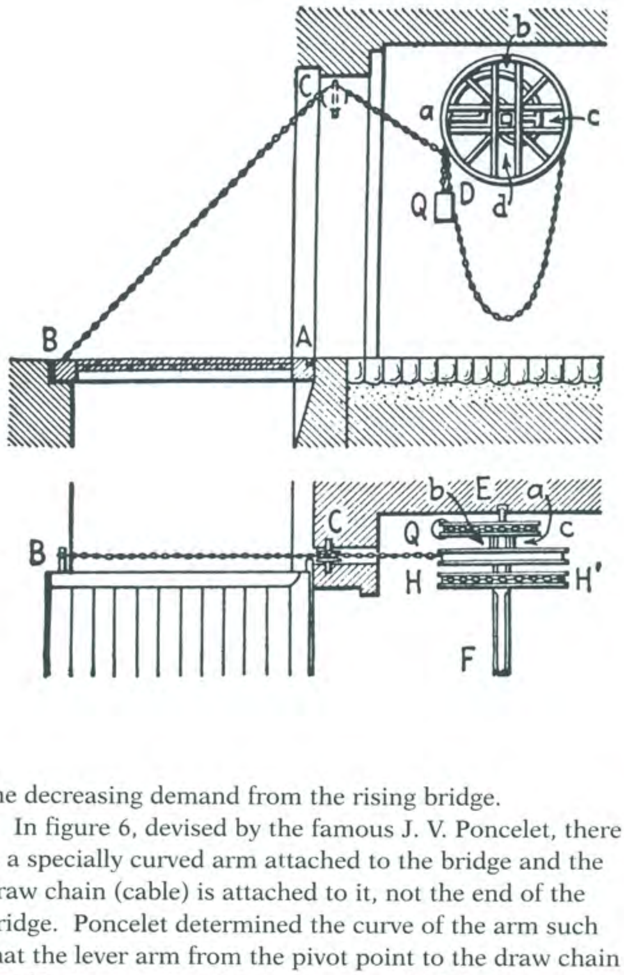


Figure 4. A modern version of a balanced trunnion bascule bridge

Figure 5. Discs used for a vertical counterweight





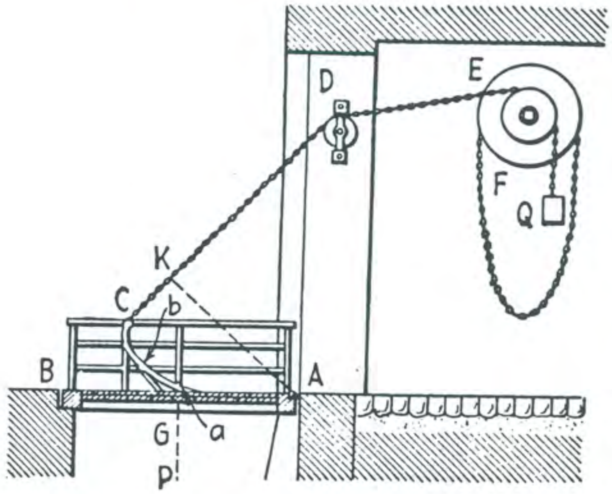


Figure 6. (Left) The spiral pulley (Above) The curved arm devised by Poncelet

the decreasing demand from the rising bridge.

In figure 6, devised by the famous J. V. Poncelet, there is a specially curved arm attached to the bridge and the draw chain (cable) is attached to it, not the end of the bridge. Poncelet determined the curve of the arm such that the lever arm from the pivot point to the draw chain (cable) decreased as the bridge rose which in turn meant that the constant counterweight Q did less work as the bridge rose. Versions of this arrangement were built during the twentieth century (figure 7).[2]

The Bélidor Bascule Bridge

The third arrangement to come from France (figure 8) is the subject of this paper. It seems to have been presented first in 1729 by Bernard Forest de Bélidor.[3] He was an eighteenth-century mathematician and military engineer whose concern was to simplify the operating mechanism and also put as much of it as possible *within* the fort, protected from attack.

Bélidor conceived the idea of a curved track proportioned to allow a constant counterweight to exert its maximum effort near the top of the tower. Then, as the

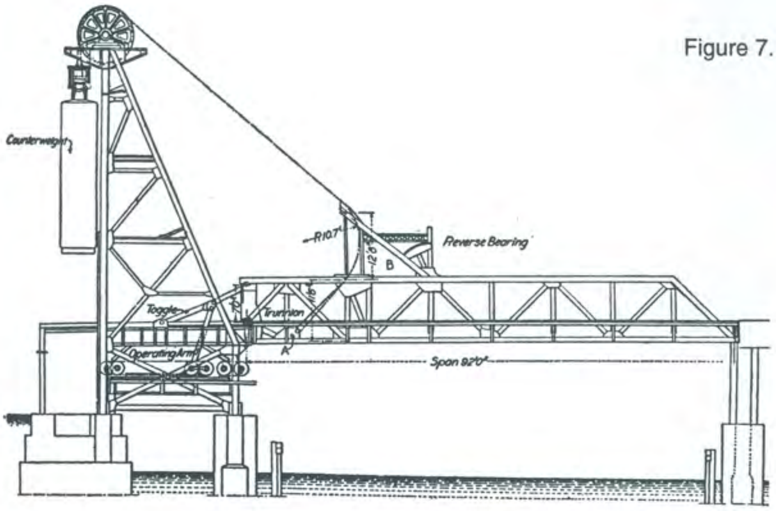


Figure 7. A 1913 Poncelet bascule bridge in Buffalo, New York

bridge rose, the position of the counterweight would change so that its work decreased, matching that required by the rising bridge.

The curve had to satisfy three conditions, two geometric and one of balance. Geometrically, the curve had to be near vertical when close to the top of the tower, hence maximising the starting effort to raise the bridge, and near horizontal when the bridge was fully raised and the counterweight does little work. The quadrant of a circle satisfies these conditions and so do many other curves, such as quarters of an ellipse or of a cycloid.

The third condition requires that the work done by the falling counterweight matches the work required to raise the bridge *throughout* the operation, opening and closing. A circular quadrant fails this condition because its "belly" is too deep and the counterweight gets ahead of the bridge, so braking is required. Then to close the bridge, winch or driving mechanism needs some help to bring the counterweight up the curve.

Ellipses and cycloids are reasonably good in maintaining balance during operations because their curves begin to flatten out higher up the curve and continue to flatten out at a faster rate the greater the distance from the tower. The circular quadrant has equal height and distance along the horizontal due to its constant radius whereas, the other two curves have much longer horizontal bases due to their more gradual flattening out. Ellipses, by definition, have different radii all round the curve so that the horizontal major axis is longer than the vertical major axis.

The Cardioid

Bélidor recommended the sine curve or sinusoid be used. Cundy[4] determined, however, that the correct shape (under the simplifying assumptions shown below) is a cardioid. One of the purposes of this paper is to compare some of the mathematical solutions already mentioned, even though none may be of practical use in fabricating the steelwork to fit each curve.

The following assumptions were made for the cardioid analysis:

1. The cable is supposed to engage the movable span at its far end;
2. The tower is the same height as the length of the movable span;
3. The span is modeled as planar;
4. The wheel at the top of the tower has negligible radius;
5. The top wheel is directly above the base hinge;
6. The initial configuration has the counterweight hanging vertically at the top of the tower; and
7. Friction is neglected.

It should be noted that some of the assumptions may not be realised in practice for actual bridges. Deakin,[5] whose derivation is reproduced here for convenience, later simplified Cundy's derivation.

Let 2a be the span of the bridge and 2a the angle it makes with the tower (figure 9). Let the distance along the cable between the counterweight and the top of the tower be r and let that portion of the cable make and angle q with the tower. With the span weight W (= Mg) and the counterweight w (= mg) then M = m÷2 and there is an initial potential energy of 2amg just as the bridge lifts with the counterweight at the top of the tower, which remains constant throughout the operation.

Conservation of potential energy now gives

$$mg(2a - r \cos q) + Mga \cos 2a = 2amg$$

or

$$r \cos q = a \div 2 \cos 2a \qquad (1)$$

Furthermore, the total length of the cable from counterweight to bridge attachment remains constant, being 2÷2a at the start of lift when the angle 2a is 90° and other angles in the triangle are 45°, then we also have for the total length of the cable

$$4a \sin a + r = 2 \div 2a \qquad (2)$$

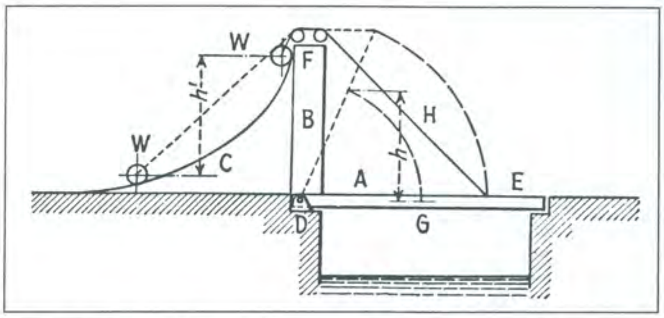


Figure 8. The curved track bascule bridge by Bélidor

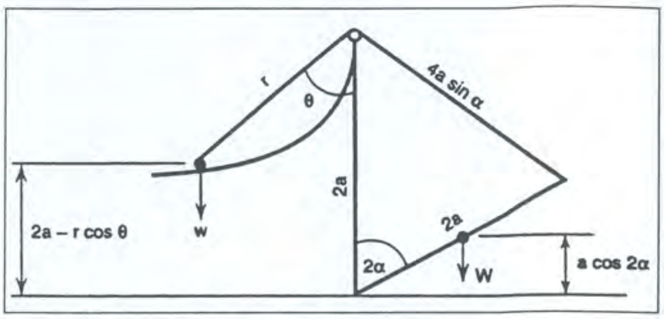


Figure 9. Diagram for deriving the cardioid

Elimination of a from these equations yields

$$r = 4 \div 2a\ (1 - \cos q\ ) \qquad (3)$$

which is the equation of a cardioid.

Equation (3) depends on the simplifying assumptions. For more general cases when some assumptions are relaxed, Deakin[6] derived the following generalised equation.

$$r^2 + 2(A \cos q - l\ )r = B \qquad (4)$$

where A and B are constants to be determined and l is the constant length of the cable. However, equation (4) still depends on one unrealistic hypothesis, that the top sheave has negligible radius.

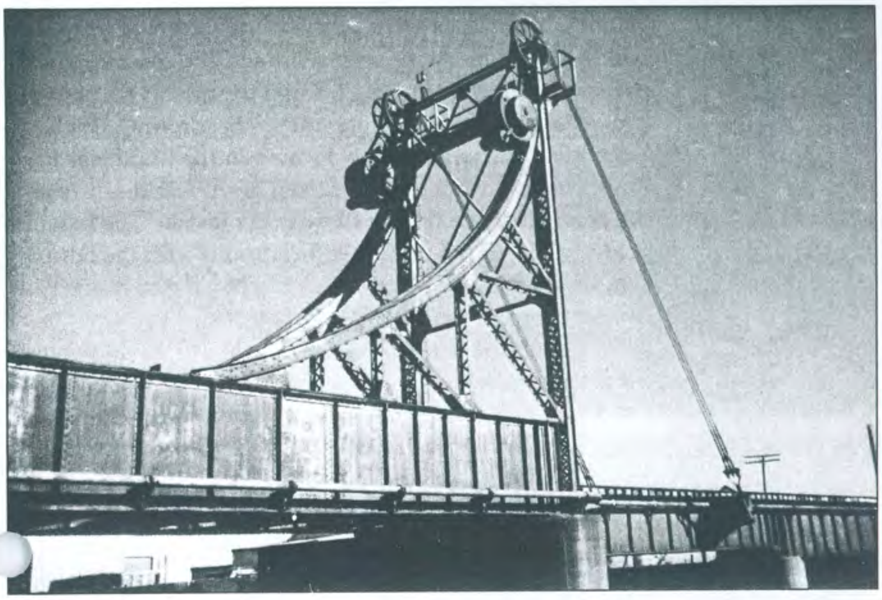
Beyond the forts

All bridges eventually become available for public use, and with the demise of siege warfare, Bélidor's bascule bridge began to find wider application as road and railway bridges. There appear to be no examples of these cited for Europe, but the authors admit that a comprehensive search of the technical literature was not made. But there are many references for Bélidor bridges in the United States. J. A. L. Waddell[7] claims the first was the 1897 Michigan Avenue Bridge in Buffalo, New York, but two earlier ones are cited by Hovey.[2] A typical example (figure 10) is the 1912 Harway Avenue Bridge in Brooklyn, New York. Waddell went on to say that "several bridge of this character were built, but, other types being more efficient, their construction was discontinued." Hool and Kinne[1] claimed that "the disadvantage of this type lies in the excessive amount of material required to construct the track and difficulty in maintaining the same."

Practical curve solution

The American emphasis on practicality and efficiency was as important to bridge design, fabrication and erection as any other endeavour, so dealing with mathematical definitions for a suitable curve was not an option. Instead they applied a graphical procedure (a very popular approach in those pre-computer days) whereby they could on a drawing board physically (figure 11) satisfy the two conditions of geometry and the all-important condition of balance (equilibrium, equality of work done or conservation of energy, whatever the terminology). The following description of the method was published in *The Railroad Gazette*[8] in 1896 and is briefly dealt with by Hool and Kinne.[1]

1. Draw the basic geometry of the bridge on a large piece of paper.
2. Elsewhere, calculate the weight, W, of the bridge and the position of its centre of gravity relative to its top surface.
3. Using elementary statics calculate the tension in the cable, which equals the counterweight, w. For most practical arrangements of this type of bascule bridge w will be between 70% and 75% the weight of bridge, W.
4. With a compass pinned at the pivot and radius to the cg of the bridge, draw an arc to the centre of the post which will mark the maximum rise, R, of the bridge.
5. In the closed position, designate the cg of the bridge as 0 and divide the maximum rise of the cg by any number of divisions, say 20, so that each incremental rise is R/20. Mark the increments and draw horizontal lines.
6. Make a template of the bridge with a hole at the cg and pin the template to the drawing at the pivot. At the lifting point of the bridge attach a longish piece of smooth-running cord. This completes preparations on the bridge side of the tower.
7. Run the cord over the sheave at the top of the tower to a convenient high place on the counterweight side of the tower and form a small loop near the top of the tower, then cut off the excess cord. The loop represents the centre of the counterweight.
8. With the bridge closed, make a pencil mark in the loop at some convenient spot. This is the corresponding 0 point for the counterweight and the start of the curve.
9. Calculate the corresponding vertical drop D of the counterweight from,



Should be road bridge from fig 13

Figure 10. A Bélidor bridge in the United States

work raising bridge = W R = work of falling counterweight = w D

hence, D = R W/w or

incremental drop = incremental rise . W/w

so now the 20 incremental drops can be marked and horizontal lines drawn. This completes the preparation on the counterweight side of the tower. The bridge is closed with its cg in the 0 position and the centre of the counterweight in its corresponding 0 position.

The typical graphical construction now follows.

10. Raise the bridge template such that its cg is on, say, the No 10 line and pin it there.

11. Take up the slack in the cord over the top sheave, put a pencil in the loop and draw an arc to intersect the No10 line of the counterweight series. This marks the balanced spot of the counterweight for position No10 of operation.

12. Repeat for all positions of operation to obtain 20 dots on the counterweight side of the tower. Join the dots to create a curve which is the locus of the centre of the counterweight.

13. Draw a parallel curve below this, equal to the radius of the counterweight which defines the curved track along which the counterweight travels.

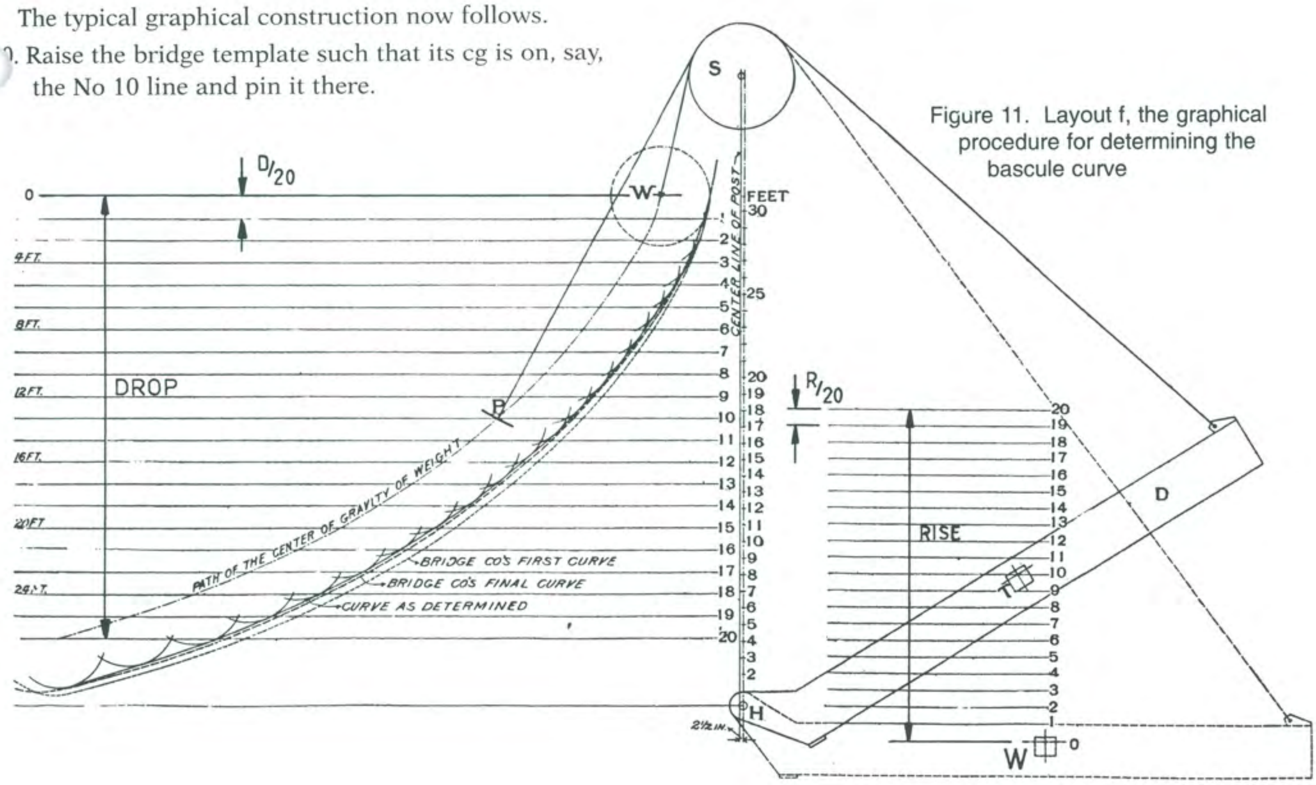


Figure 11. Layout f, the graphical procedure for determining the bascule curve

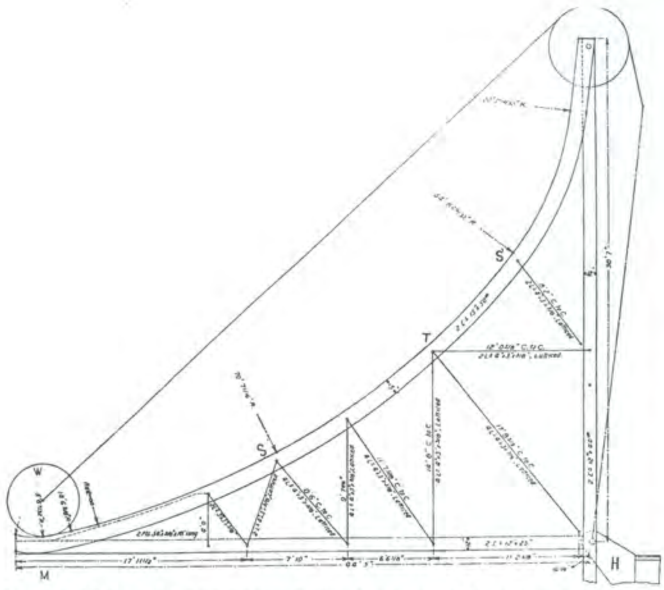


Figure 12. Typical compound circular curves for a curved bascule track

This graphical procedure has the advantage that it deals with the real structure whatever the arrangement of its details. There are no simplifying assumptions. For situations that match the earlier assumptions, the graphical curve should match the cardioid solution whereas, for a more general arrangement, it becomes a question of how well the cardioid matches the graphical curves. Comparisons are dealt with later in the paper.

Compound circular curves

Setting out the curve of the track for fabrication would have been possible using a full scale template with frequent comparisons as the metal sections forming the track were progressively bent to follow the ever changing radius of the curve. This would have led to an excessive amount of movement of sections to and from the workshop.

However, fabricators have been bending metal sections to circular curves for centuries, accurately and cheaply, so it was logical to make the track from a series of circular curves, sharp near the top of the track and flattening out towards the bottom of the track. The compound curves (figure 12)[8] are for the graphical construction (figure 11). Another example will be shown when discussing the use of curved track bascule bridges in Australia.

The Australian experience

New South Wales, Australia has had a need for movable span bridges over its three navigable inland rivers, the Murray, Murrumbidgee and Darling, and for ten east coast rivers since the 1860s as the expanding road network and its increasing traffic forced the gradual elimination of ferries/punts. A comprehensive review through to 1915, by co-author Fraser, has been published.[9]

Initially lift bridges were popular but there was always a conflict between the optimum lift and the mast heights of the shipping. Some swing bridges were built because they provided a clearway of unrestricted headroom. But a large pivot pier was usually located in the middle of the main channel where craft of deep draft would prefer to be, particularly at times of low water levels. The bascule bridge also offered unlimited headroom with the advantage of placing the clearway, created by the movable span, over the main channel (figure 13).

Although the bascule bridge (figure 5) had these attributes, the sectional disc counterweights were operationally poor and so a bridge was sought with a smoother action and requiring negligible effort by the operator. Harvey Dare[10] of the Roads and Bridges Branch, Department of Public Works, selected the curved track bascule bridge from among the array of bascule bridges being built in the United States in the 1890s. Copies of his calculations and graphical construction survive, as do the working drawings for each of the six such bridges built between 1905 and 1912, as well as a 1924 version. These were all single lane road bridges. Only one such bridge was built for a railway, in 1925 (figure 13).

Dare's calculations show just how closely he followed the America system of design and working details as well the graphical procedure for determining the curve of the track. He also adopted the practical step of fitting compound circular curves to approximate the graphical solution (figure 14).

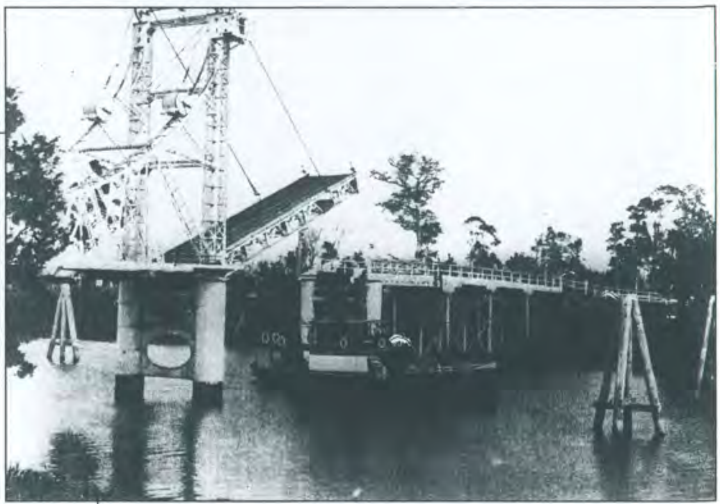
He seems also to have added a refinement to the counterweights more clearly seen on the railway bridge (figure 13b). Each roller weight has a transverse bar below it. On that bar he arranged for small discs to be added during trial operations so as to achieve the smoothest action.

Comparing the curved-track solutions

The earlier sections of this paper identified some solutions for determining the locus of the centre of the counterweight, namely, Bélidor's sine curve, suggestions for an ellipse and a cycloid, a cardioid, a circular curve (intuitively poor), a graphically-derived curve and a curve formed by portions of circular curves (a composite curve of circular arcs).

Mathematician Michael Deakin has had access to Harvey Dare's calculations for the first of the curved-track bascule bridges built in New South Wales, at Telegraph Point in 1905 but long since demolished. He used the set of coordinates from Dare's graphical work as the "exact" solution and then calculated curves of best fit for the cardioid, an ellipse, a quadrant of a circle and the composite circular arcs. The discrepancies can be represented graphically (figure 15), relative to the "exact" solution which is the zero line. Point 1 is the top of each curve with point 24 at the bottom terminations.

As expected, the circle is the poorest approximation with a maximum relative error, in the horizontal displacements of the centre of the counterweight, of 10.3%. Its effect on



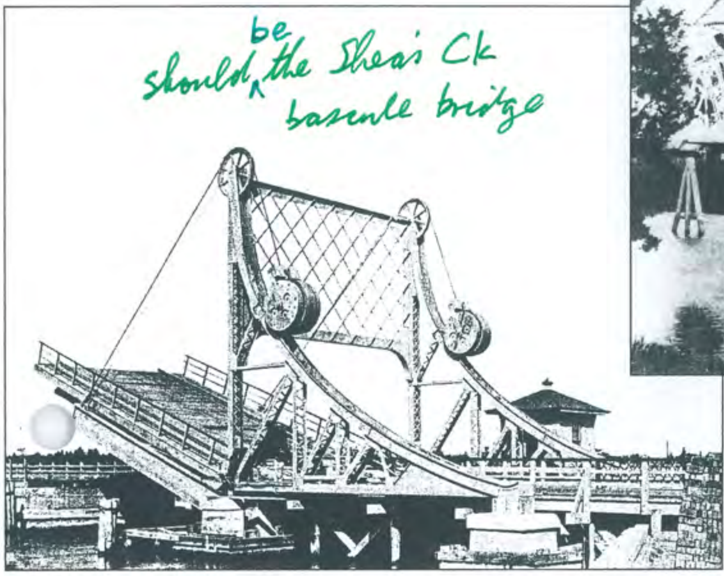


Figure 13. Road and rail curved track bascule bridges, New South Wales, Australia

operating the bridge will be discussed shortly. The ellipse, which qualitatively has the right shape, is a better approximation with a maximum relative error of 3.2%.

However, the cardioid fared slightly worse with a maximum relative error of 5.1%. This occurred because certain assumptions in the theoretical derivation were not met in the actual construction of the bridge. Specifically, the pulley sheave at the top of the tower had a finite radius (not negligible), the centre of this pulley was not directly above the hinge of the movable span, the counterweight roller is of finite size (not a point), the lifting point on movable span was not at its far but about three-quarters along, and the length of the movable span did not equal the height of the tower.

The best solution was the composite curve of three circular arcs, a practical graphical matching of the "exact" graphical curve, with a maximum relative error of only 1.4%.

The basis for these comparisons was a set of twenty-four coordinates for each solution using the centre of the top pulley as the origin with y measured vertically downwards and x measured horizontally. This made it possible to draw graphs (figure 16) of the circular solution and the cardioid and compare them in terms of operating the bridge (all numbers are inches). We know the cardioid (5.1% error) is closer to balanced operation than the circle (10.3% error) so the graphical differences represent differences in operating efficiencies.

As raising the movable span starts, the circular locus stays above the cardioid which means the fall of the counterweight is not enough to produce a balanced lift, so the operator has to work harder on the winch (originally down at deck level, then moved to the top of the tower to reduce transmission friction). But around halfway, the situation reverses and the fall of the circle exceeds the balanced condition. The counterweight is starting to run away so some form of braking would need to be applied.

For lowering the movable span. The counterweight, at the bottom end of the track, is below the balanced state so the operator has to work hard to help "lift" it up to the halfway mark. Then, as the counterweight moves higher, its position is above the balanced position, so the movable span starts to gather pace as it approaches its horizontal place. Gentle bedding will not occur unless some braking is applied.

With three circular arcs (six in later versions, figure 14) closely matching Dare's "exact" graphical solution, operations (raising or lowering) using a manual winch were smooth, in only five minutes, ample time for the relatively slow approaching river craft. It is not surprising to learn that some years ago an elderly bridge operator was interviewed and he claimed that the bridges in New South Wales were easy to operate.

Conclusion

The curved-track bascule bridge (the Bélidor bridge) began as an item of military infrastructure in eighteenth-century Europe at the entrances to castles and forts. Then, as the canal systems in Britain, Europe and America expanded in the nineteenth century, many of the road and rail crossings used various forms of bascule bridges, including the Bélidor bridge, with low-level decks not far above the water.

Around 1900 the merits of the Bélidor bridge came to the attention of Australian engineer Harvey Dare, who used the American experience to design seven for the navigable rivers of New South Wales, six road bridges and

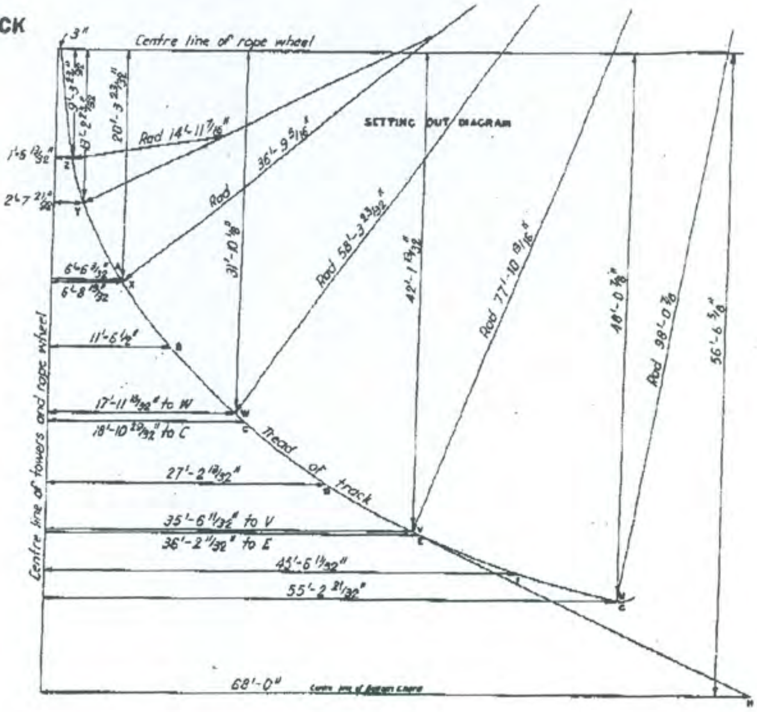


Figure 14. Track settings by Harvey Dare

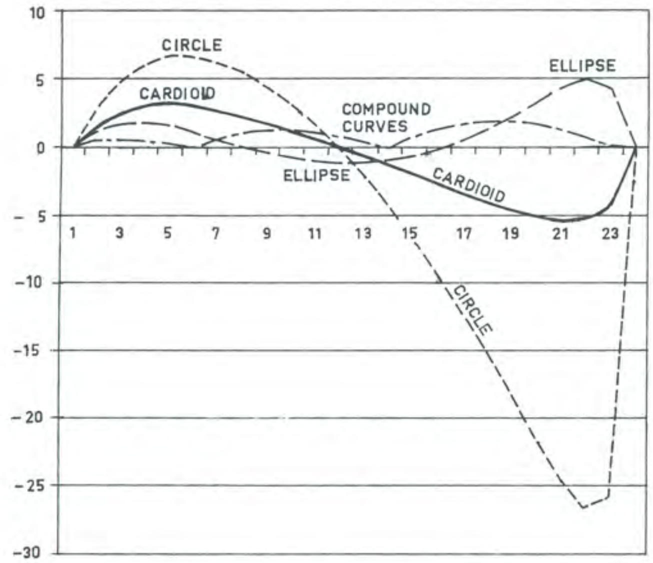


Figure 15. Relative errors of four curved-track solutions

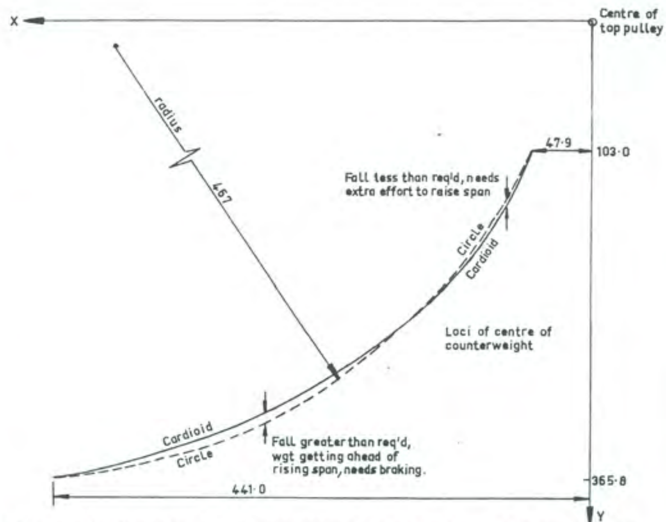


Figure 16. Graphical comparison of the circle and the cardioid

one railway bridge. The bridges were successful for their purpose, which lasted until the mid-1920s.

As of 2001, three of the road bridges are still in use, and at one site, the tower structure was re-erected as the entrance portal to a riverside caravan site. The three survivors have high heritage status under the Heritage Act of New South Wales, so the prospects are good for the long-term preservation of these historic bridges.

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CLARENCE RIVER HISTORICAL OVERVIEW

This review is based on text extracts and images from the source documents in the References of the Nomination Assessment, particularly the publications by Eleanor McSwan for the Maclean District Historical Society Inc. They put the McFarlane Bridge in its historical and commercial context. However, the history, details and archival plans of the bridge are presented in a separate section of this Nomination Report.

The Big River

This name was initially applied to the Clarence River around 1835 by escaped convict Richard Craig who, during his 7-year trek south from Moreton Bay (Brisbane) to Port Macquarie, passed through country with vast stands of timber (particularly cedar) and crossed a "big river". He was of course referring to its width and had no idea that his description was apt, because the Clarence River (so named officially in late 1839) has the largest coastal river catchment in NSW and the greatest flow. The BIG RIVER title has been used in informal and praiseworthy terms ever since.

Map of the Maclean Shire showing principal features.

However, the famous navigator Matthew Flinders had entered a wide shallow bay on 11 August 1799 during a coastal survey for Governor Hunter. He was not impressed with what he saw and did not explore the area, so was unaware of the large river entering the western side of what he named Shoal Bay. But he recorded the latitude and noted a prominent peak a short distance inland, later known as Clarence Peak and now Mt Tucabia) which enabled Flinder's landfall to be positively identified as the "big country" region.

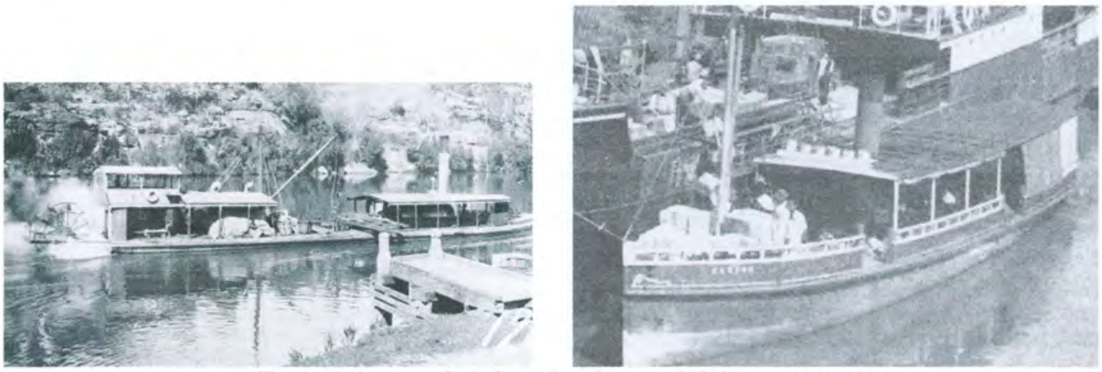
News of the abundant red cedar, for which there was a high demand, prompted private citizens to finance visits to the river for exploitation of this valuable resource. Richard Craig's employer, Thomas Small of Kissing Point, Ryde, was the first. His expedition on the schooner *Susan* (hence Susan Island at Grafton) entered the river in mid-1838 and soon reached a river junction. The southern river was later found to be an arm of the main river, hence the name South Arm, which enclosed a large fertile island, now Woodford Island. Maclean was established in the 1860s on the north side of the junction and initially an early hand-operated ferry then the 1906 McFarlane Bridge linked it to Woodford Island.

Map showing details at junction of Clarence River and South Arm.

Unfortunately, cedar getting was one of the worst examples of the thoughtless plundering of nature. By 1870 no cedar was being shipped from the Clarence and the men had moved north to the rich resources of the Richmond River.

Settlement

However, the transient nature of cedar getting was ignored by the arrival of settlers, Scottish, Irish and German, as early as 1840. Capt. Butcher on the *Abercrombie* had already proved that the river was navigable for about 80 miles (130 kms) from the entrance, truly a big river. The adjacent lands were mostly on the fertile flood plain downstream from the future Grafton and the region became known as the Lower Clarence. Farming and grazing quickly became the staple industries but grazing for meat eventually moved to more suitable country of the Upper Clarence leaving dairying on the Lower Clarence. Long term activities, right up to the present day, have been maize, sugar, dairying and fishing.


Typical river craft, left, a drogher and right, a steam tug.

The steadily increasing productivity of the "isolated" Lower Clarence, some 440 miles (700 kms) from its principal market in Sydney, was sustained for 100 years by the "highways of the waters". On the Clarence River, its lower tributaries and the many arms surrounding fertile islands, it was by small craft such as tugs, droghers, barges and punts; and by the sea-going ships of the North Coast Shipping Trade.

Shipping

The sea-going fleet consisted of some private operators but the bulk of the Trade was carried out by substantial shipping companies that became bywords along the North Coast of NSW, the Grafton Steam Navigation Co., Clarence and Richmond S N Co., Clarence and New England Navigation Co., Clarence, Richmond and Macleay Rivers S N Co., Nipper and See, John See and Co., and the most substantial the North Coast Steam Navigation Co. (1891-1954).

S S Kyogle on the Clarence River near Maclean.

The waterways were busy with waterborne cargoes and passengers and servicing the villages, towns, farms and factories particularly sugar mills.

Railways

All this changed after 1922 when all sections of the all-weather, safer North Coast railway from Maitland to South Grafton were completed. The shuttle fleet on the river system was little affected, South Grafton remained a river port and so the river trade lasted another 30 years until road transport on the improving Pacific Highway and on the network of local roads began to reduce the dependency on the river.

The railway's most immediate effect was to divert Sydney-destined cargoes and passengers from the vagaries of sea conditions and dangerous bars at river entrances. The North Coast Shipping Trade began to decline as early as 1913 as the railway reached each navigable river from the Manning to the Clarence.

River entrance works

All the coastal rivers from the Hunter to the Tweed had, and most still have, dangerous entrances due to sediments from the rivers and shoreline sand forming sandbars and shoals just outside the entrances or estuaries – called bars. They were usually shallow with shifting channels and perpetual rough seas due to a combination of tidal flows and sea conditions. Frequently, ships could not cross a bar and could be bar-bound for many days until nature changed the situation. Frustration could lead to disasters.

The all too frequent wrecks, left, a ship bar-bound and right, a spectacular collision with a breakwater.

During the colonial years 1873-1896 alone, there were 419 shipwrecks along the NSW coast of which 101 were lost on bars, mostly on the North Coast, with large losses of expensive ships, valuable cargoes and human lives. Consequently, successive Colonial Governments and the early State Governments spent millions of pounds on improvement works through the Harbours and Rivers Branch, Public Works Department. Works such as dredging and building river training walls, entrance breakwaters and lighthouses.

Establishing reliable, non-shifting channels through the bars was the key endeavour, particularly at the entrance to the Clarence River because the river had become the centre of the north coast trade. Shipowners regularly complained and lobbied about delays in getting across the bar, which adversely affected their operating costs and profits, and the interaction with dependent river traders.

The story of the successful entrance works that are in place today for the Clarence is a long, tangled saga. It involves politics (local, government and commercial), economic factors (budgets, costs, profits, cost-effectiveness), engineering (successes and failures of designed works), grand schemes (deep-sea port project), railways (North Coast and East-West railways from the New England region) and conflicts of interest (John See, Premier 1901-1904, was also the principal shareholder and Director of North Coast Steam Navigation Co.).

Suffice to say that only some of the story is relevant to the McFarlane Bridge across the South Arm at Maclean, which had to accommodate river traffic with its bascule span and provide a working link between the quarry on Woodford Island and the various stages of the entrance works.

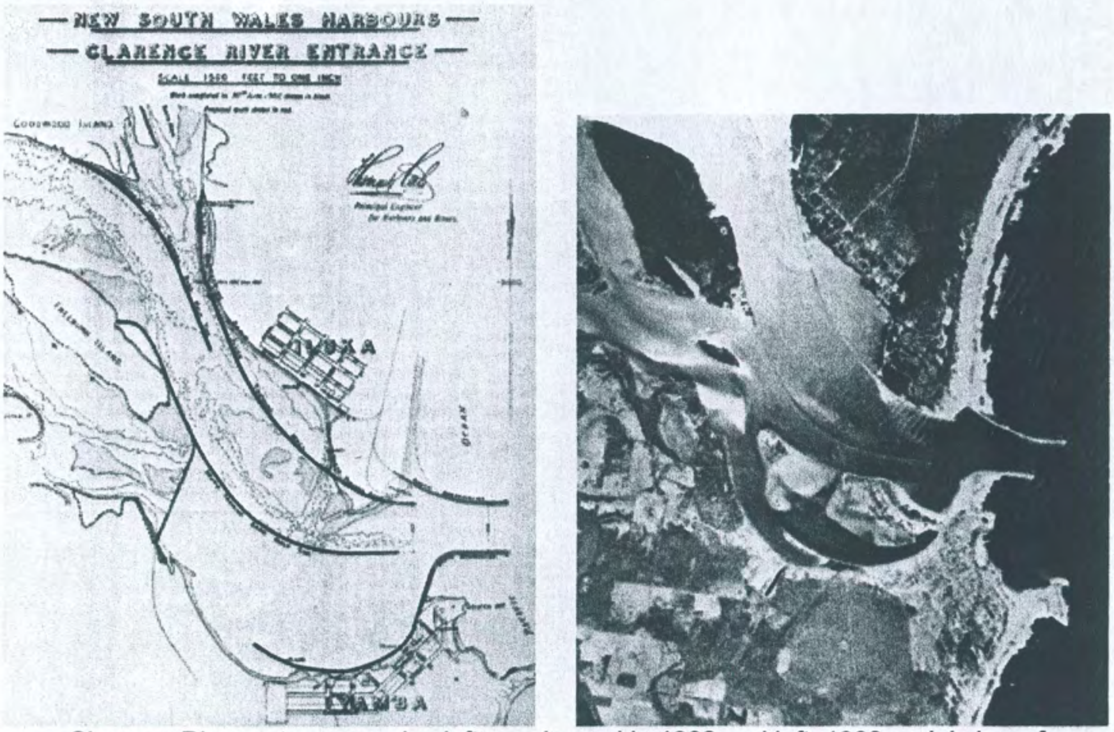
Briefly, in 1885 the Colonial Government engaged British marine engineering expert Sir John Coode to visit the Clarence and other North Coast rivers and to submit a report on recommended improvement works. His report is available in the NSW Legislative

Assembly's Votes and Proceedings, 1887-8, vol 3, p 899+ with plans. His three main recommendations were, build two parallel breakwaters, remove the rocky reef across the entrance and make up-river improvements to better guide the flow to a wide 18-ft channel through the bar.

For a major river such as the Clarence, it would be an expensive capital work but its design philosophy had long term benefits. On-shore wave action pushed the river sediments and littoral sands into the entrance and progressive accumulation created the bar. Floods and other natural actions kept shifting whatever channels that formed. Coode's design would take the interface of wave action and river flows further out to sea with a "trained" concentrated flow between the breakwaters creating a stable channel. Infrequent large floods had always cut a safe channel but soon after, the bar reformed.

Coode's aim was to keep sand and sediment moving seawards by continuous natural means rather than constantly removing it by expensive and often ineffective dredging. The initial high capital cost would be recouped through negligible on-going maintenance.

The scheme was approved by the Parliamentary Standing Committee on Public Works in 1889 and work began in 1890 with great expectations. In 1902 the engineers of the Harbours and Rivers Branch produced a modified design that retained Coode's basic recommendations.



Clarence River entrance works, left, as planned in 1902 and left, 1969 aerial view of completed works.

Then all manner of problems and delays began such that by 1905 £500,000 (an enormous sum for the times) had been expended with almost nil benefits. Henceforth, successive Sate Governments refused to allocate adequate funds, plus the Great Depression of the 1930s and Word War II intervened. But essential dredging continued and the accumulating bill continued to mount. Cost-effectiveness was near zero.

The on-off, mostly off, process continued until the 1960s when construction of the breakwaters resumed using concrete blocks weighing as much as 40 tons each. The southern breakwater was completed in 1965 and the northern breakwater in 1969 almost 80 years after Sir John Coode had submitted his report.

Modern coastal engineering monitoring equipment, hydraulic models and complex computer analyses have confirmed Coode's basic tenet of making nature clear away the offending bar material rather than removal by dredging. Costly ineffective dredging has been suspended.

Finale

By 1973 the North Coast Shipping Trade had long since ceased, river transport had been largely superseded by road transport and the dream of a deep-sea port had been officially abandoned.

The completed entrance works are maintaining a stable channel albeit for recreational and tourist craft and fishing trawlers.

At Maclean, tall-funnelled steam craft have been replaced by squat diesel-powered craft which can pass under the bridge. The bascule span became redundant so was locked down and the roller counterweights were replaced by hollow dummy replicas. However, the bridge continues in service for road traffic.

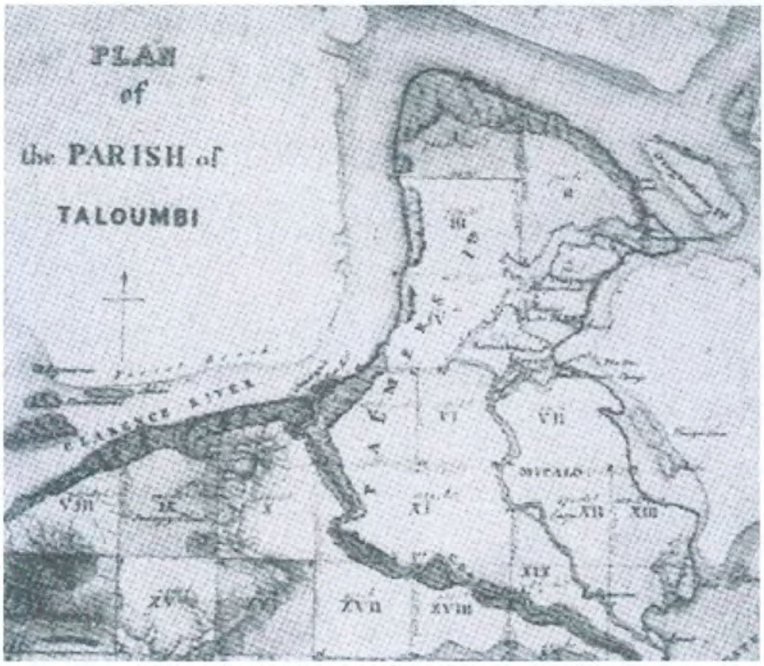
The McFarlane Bridge 2005, closed to shipping, only for road traffic, cyclists and pedestrians.

HISTORIC MACLEAN

This historical summary only covers the period to 1912 which is sufficiently relevant to the association of Maclean and the McFarlane Bridge. The source is Eleanor McSwan's "Maclean – the first fifty years, 1862 – 1912".

Maclean is the commercial centre for the Lower Clarence and was, until the recent local government amalgamation into the Clarence Valley Council, the headquarters of the Maclean Shire Council.

As noted in the Historical Review, the first settlements along the 'Big River' (Clarence) were the cedar getters' temporary camps, but in 1840 the first steps of official settlements took place when Surveyor W C B Wilson set about dividing the country into Parishes. The one that included a reserve for a future township was the Parish of Taloumbi.



Wilson's 1842 map of the Maclean area.

Alexander Maclean.

The reserve, on the east side of the junction of the Clarence River and the South Arm was the site of the initial settlement called Rocky Mouth due to the group of rocks at the entrance to the South Arm. Even after the site was officially named Maclean in 1862, Rocky Mouth remained in use until 1885. But the large alluvial island opposite the reserve across the South Arm was named Woodford Island by Surveyor Greaves after a General Woodford who fought in the Greek War of Independence 1821-1830. However, development at the initial settlement was slow such that by the 1860s other settlements at Ulmarra, Lawrence and Ashby were bigger than the as-yet-to-be-named Maclean. Then in May 1862 Surveyor-General Alexander Maclean toured the Lower Clarence with Surveyor Greaves who, in June, laid out a township on the aforesaid reserve naming it Maclean, after the Surveyor-General.

Despite the slow start, Maclean overtook the other settlements by 1872 and became firmly established as the servicing centre for farmers of the Lower Clarence. Its proximity to the Clarence entrance seemed to give it an advantage as the first port of call for ships and the transfer of cargoes and passengers to and from the river craft. There was also a stretch of deep water suitable for wharfage for sea-going ships.


S S Kallatina at Maclean wharf.

Portion of Scottish settlers' farms (small dots) near Maclean.

Present-day Maclean enjoys a strong Scottish connection through the Maclean Clan dating from the 1860s, not because a Scottish name had been chosen but because of the large number of Highlanders who emigrated to New South Wales 1837-1852 and many settled in the Lower Clarence in the early 1860s. This was made possible by Sir John Robertson's 1861 "Free Selection Act" (applicable to all of NSW) which introduced regulations that enabled people with little capital to take up small parcels of land. The Scots settled all over the rich alluvial flood plain between Grafton and Palmers Island with Maclean the commercial and administrative centre.

By 1882 Maclean had become second in importance to Grafton on the river and was centrally located in a rich sugar growing area. It had three good wharves for sea-going ships and the venue of the District Court. It had daily communications with Grafton by steamers and a flotilla of smaller craft, all of which had a significant influence on the choice of an opening-span bridge across the South Arm between Maclean and Woodford Island some twenty years later.

A significant generator of river traffic for 120 years was the success of sugar growing which began in the 1860s with the arrival of some planters from the sugar-rich West Indies. They recognised the suitability of the land and the climate for growing sugar, and there was water transport available to provide an economical mode between farms and sugar mills, a steam tug could pull up to 8 heavily laden punts/barges.

By the end of the century the sugar industry was firmly established and there were some 80 mills on the Lower Clarence, mostly privately owned and operated. However, after 1874 when the Colonial Sugar Refining Co. (CSR) commenced operating its large mill at Harwood, a short distance downstream of Maclean on the north side of the river, its scale of production and efficiency meant that most of the small mills could not compete.

Eventually CSR established a monopoly and used its own fleet of tugs to collect the huge sugar cane harvests.

Aerial view of the Maclean-Harwood region. Maclean is the township, with its McFarlane Bridge connection across the South Arm to Woodford Island (bottom left)). The Clarence River sweeps away to the top right where, somewhat indistinctly, are the 1966 Harwood Bridge and the Harwood Sugar Mill.

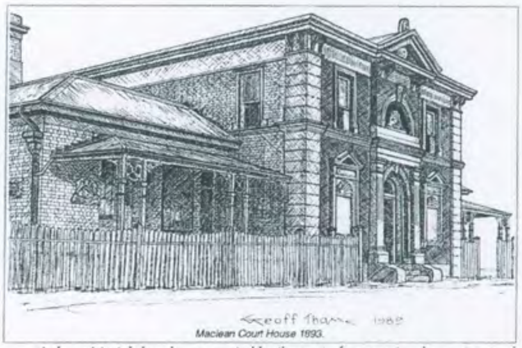
One of the principal areas of sugar growing was Woodford Island opposite Maclean and in easy reach of the Harwood Mill. The frequency of water traffic, particularly at harvest times with many high-funnelled steam tugs, meant that when a bridge, the future McFarlane Bridge between Maclean and Woodford Island, was being considered, it had to include an opening span, even though some tugs had hinged funnels for laying back in the horizontal position. Such innovations and the changeover to low profile diesel tugs eventually led to the redundancy of the opening span. But it served a degree of usefulness until the 1980s when the combined effect of road transport and the 1966 Harwood Bridge ended the river trade era. The distinctive bascule bridge at Maclean became an historic engineering relic.

Maclean benefited enormously from the increasing sugar revenues during the boom years of the 1880s such that the Colonial Government financed some elegant architectural developments, a Post Office and a Court House, and new hotels were built. On 31 December 1887 Maclean was proclaimed a Municipality and David See became the first Mayor. It developed into the Maclean Shire Council with its Council Chambers in Maclean. Despite the infamous economic depression of 1892 and four large floods in 1892-93, Maclean recovered and entered the twentieth century in a prosperous condition. John McFarlane MLA, Member for Clarence, continued to promote the district and lobby

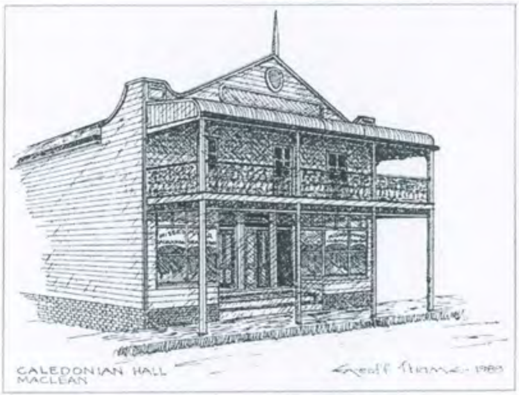
Governments for improvements, the largest of which was the 1906 bascule bridge, named in his honour. The bridge is dealt with in another section of this Nomination Report.

Maclean's architectural gems

Sketches by Geoff Thame fromEleanor McSawn's – Maclean, the first fifty years, 1862-1912.



Maclean Court House and Australian Bank of Commerce (left



Caledonian Hall and Commercial Hotel

Argyle Hotel and Maclean Hotel