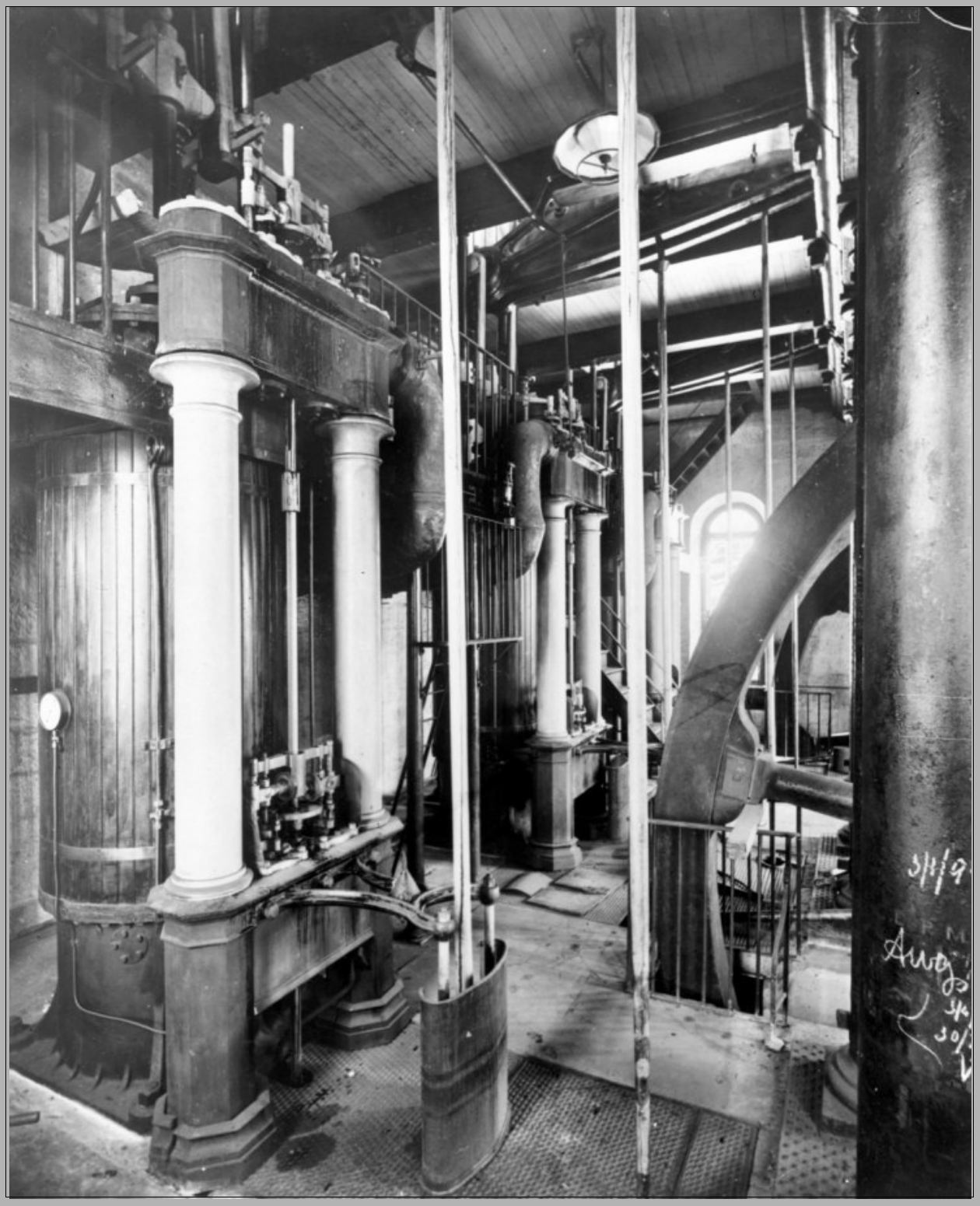
ENGINEERS AUSTRALIA

EHA MAGAZINE



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Engineering Heritage Australia Magazine

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EDITOR:
Margret Doring, FIEAust. CPEng. M.ICOMOS

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Cover Images:

Front: The 3 steam cylinders & 2 flywheels of the pumping engines at Botany Pumping Station, Sydney, photographed c1896. For more information see page 13.
Source: Sydney Water Photo Collection.

Back: Kempsey Railway Bridge over the Macleay River, viewed from the south (Sydney) side of the river. The pedestrian path over the river can be seen on the left side.
Source: Australian Railway Historical Society.

This is a free magazine covering stories and news items about industrial and engineering heritage in Australia and elsewhere. It is published online as a down-loadable PDF document for readers to view on screen or print their own copies. EA members and non-members on the EHA mailing lists will receive emails notifying them of new issues, with a link to the relevant Engineers Australia website page.

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This EA Centenary book is still for sale at
https://www.eabooks.com.au/Anything-is-Possible

Editorial

I never know from one magazine to the next what I will be able to publish. Sometimes stories for the next magazine are all lined up, like ducks in a row waiting to be edited, before the previous magazine is completed. Sometimes I have promises, promises and only one, maybe two stories ready to go, but then too often I am left floundering in a panic wondering if I will have anything at all to fill the pages – Oh help! Am I going to have to write something?

This time, it was a case of the first instance – but embarrassingly so! Just after the January 2021 magazine went online I sent a notice of its arrival to the Heritage Chat groups in NSW and Victoria, with an appeal thus: *We are seriously short of stories for the next few issues of the Magazine, so if any of you can think of an interesting subject you would like to write about, please get in touch with me.* The response was quite amazing. Within a few weeks I had first drafts or promises enough to fill at least the next two issues. A few of those promises haven't materialised - but I will get back to them when I am looking for the next lot of stories!

Now to the stories in this issue – they cover floods, shipwrecks, epidemics, drainage and water supplies. Jennifer Preston's story is about Edward Bell, a 19th Century Sydney City Engineer, who developed Sydney's first major water supply infrastructure, some of which is still in constant use 160 years after he designed and built it. I have to thank Dr Preston for her considerable work in turning a formal architectural history conference paper on Edward Bell into a story for this magazine.

My always reliable contributor Bill Phippen has given us another of his stories mined from his diggings into the wonderful collection of photographs from NSW State Rail Authority Reference Photo Collection, now digitised by Bill and his Australian Railway Historical Society colleagues and lodged with the NSW State Archives and Records. This story records the damage wrought by the great 1950 flood to the railway viaduct across the Macleay River flood plain at Kempsey, in northern NSW, completely cutting rail access between Sydney and Brisbane on 24th June. The line was re-opened on 20th August, only 57 days later. A major operation completed in an astonishingly short time in such a remote area, hundreds of kilometres from the nearest supply of construction materials and machinery. It's a great story.

Perry Beor, an engineer from the Western Australia Water Corporation, was inspired by our recent problems with Covid 19, to write about how Perth overcame another devastating epidemic that happened in the region more than 100 years ago. No, it wasn't the Spanish flu, but Typhoid - another horrible disease, which accounted for many thousands of deaths world wide in the 19th Century. Vaccines had been invented near the turn of the century, but were not commonly available - and certainly not in far-flung regions such as Perth was in 1900. Perth's answer to the epidemic of the 1890s was to improve the drainage systems of the city, and to build a better and more safe water supply. The city was justly proud of its achievements in improving the collection and disposal of sewage, and in 1901, commemorated it with a concrete plaque, cast into the underground wall junction of two main drains. The plaque, being underground, in an operating sewer, was only rumoured to exist, until it was rediscovered by Perry's team earlier this year, thereby becoming the hook on which he hangs his story!

Writing about early marine steam engines was a new venture for Warrwick Hoad, a chemical engineer who retired to live at Angourie, on the north coast of NSW, where the surf is highly regarded, but not much else had happened since the wreck of the *SS Phoenix* in 1852. He was intrigued by the fabled continuing presence of this wreck under the sand, and began researching it. He says it has kept him sidetracked for a few years. He was encouraged to write about the *Phoenix* by his friend Rex Glencross-Grant, another engineer and academic who lives near Warrwick and has written for this magazine. Warrwick asked me to add, at the end of the *Phoenix* story, this sentence: *The author would like to thank R Glencross-Grant & M Doring for their encouragement.* Encouraging also for me, but there was no room after the story. I was intrigued by this photo Warrwick sent. It has no explanation as to why these two engineers – Rex at left and Warrwick at right – are carefully posed, on SRG scaffolding, way above the ground, in some unidentified bushland.

And now I've left myself no room to give a proper account of what I think was the most terrifying experience of my life – living on top of a mountain only about 50 kilometres from the epicentre of the biggest earthquake ever recorded in Victoria. It only lasted a couple of minutes, and there was no structural damage to our house, but it was so overwhelmingly powerful, it left me in a state of shock all day.

Margret Doring, FIEAust, CPEng.

The Story of the Paddle Steamer SS Phoenix

By Warrwick Hoad

The Phoenix legend

In classical Greek antiquity, the Phoenix, a legendary bird, lived for 500 years before being endlessly resurrected from the ashes of its nest for another life cycle.

The Phoenix in this story, was a steam ship – a paddle steamer – which began sailing the NSW coast in 1846. Alas, the SS *Phoenix* was not so fortunate, having a lifespan of only 6 years, although it did have two lives, having been raised once from the dead after a supposedly fatal wreck.

Strictly speaking, SS *Phoenix* was already on her second life when she was launched in 1846. She was built as the replacement for another paddle steamer, the SS *Sophia Jane*, which had plied the NSW coast for nearly 20 years before SS *Phoenix* rose again, incorporating Sophia Jane's original side-lever engine.

The legendary Phoenix – by F.J. Bertuch, 1806.

A Summary of the Life of SS Phoenix

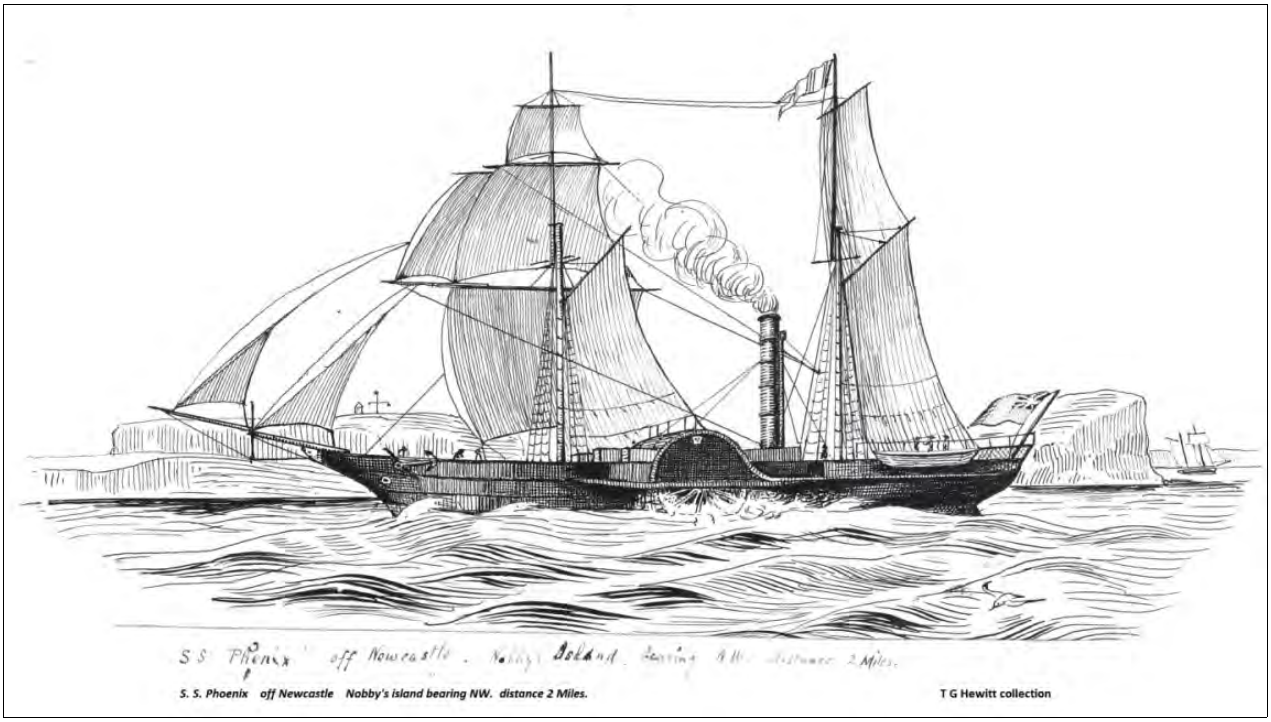
The SS *Phoenix* was a 108 ft long steam packet that plied the Sydney-Grafton route from 1846 to 1852. Steam packets were sail boats with auxiliary early marine steam engines driving a paddle wheel.

The *Phoenix* was built in Sydney in 1846 and used the 'recycled' steam engine from the SS *Sophia Jane* packet.

The *Phoenix* was wrecked twice:

- 3 March 1850 on back Angourie Beach.
- 14 April 1852 on the Clarence River bar.

She was salvaged and repaired after the first wreck, but was permanently lost on the second. This story describes the origins and history of the *Phoenix*.



"SS Phoenix" off Nobby's Head, Newcastle, 1846, from the T.G. Hewitt Collection, Lismore Museum. – artist not-named. This drawing is probably not contemporary with the ship. Hewitt (1841 - 1915) was still a boy when "Phoenix" was sunk, and she appears to be flying the Australian flag, invented in 1901.

The Story of the Paddle Steamer SS Phoenix

SS Sophia Jane

The paddle steamer, *Sophia Jane*, was built about 1826 in the London East End docklands area by shipbuilder Williams Evans. The SS *Sophia Jane* was a 256 ton brig, 126 ft long and 30 ft across the paddle boxes.[1] Barnes and Miller (Millwrights in London) produced and fitted her 50 horsepower engine. The engine was a 'side lever', designed to lower the centre of gravity of the engine to reduce a small steamship's tendency to capsize in heavy seas. She was launched about late 1827 and initially provided a passenger service between Liverpool and the Isle of Man and later the Channel Islands and France.

She was sailed to Australia, arriving in Sydney in May 1831. . . . *Steam navigation will help greatly to raise the character of this Colony abroad, and to improve it at home. The addition of such a vessel as the "Sophia Jane" to our coasting trade is a most gratifying event. It is almost in the trading world what a new Governor would be in our political hemisphere. A fresh spirit will be infused into all our settled and unsettled districts that can be approached by water. Persons will shortly be able, we expect, to breakfast in town, lunch at Newcastle, dine at Port Stephens, and put up comfortably at Port Macquarie next morning, at half the present expense and in quarter the time, of the journey to Wallis's Plains. Should she not find enough to do between this and Newcastle, the route to and from Hobart Town lies open, and to Western Port, when the fine line of coast about there shall be settled.*[2]

After refurbishing the steam engine system, the Sophia Jane began plying the Sydney-Wollongong route. Over the years, she also did runs to Morpeth, and further north to the Clarence River. The Sophia Jane was the first steam ship to operate in Australia.[3]

After several changes of owners, Edye Manning, a Sydney shipping magnate, bought her in about 1844.[4] However, her age was catching up with her. She was docked for a week in late 1844 for repairs, and suffered damage with the *Tamar* off Newcastle in March 1845. Repairs took another week. Her boilers were by now about 19 years old and past replacement date. The proprietors decided to scrap her in August 1845.

"Sophia Jane" Steamer.

THE Proprietors of this Vessel regret to have to withdraw her from a trade in which she has met with such liberal support from the public, particularly during the last six months, but as repairs are requisite to a greater extent than it would be prudent to encounter, they are reluctantly compelled to suspend her trips. It is, however, in contemplation to build a NEW STEAMER, of such a stamp as to ensure the favour of the public. The "Sophia Jane" will leave Morpeth for Sydney on Monday Morning, for her last trip.

Morpeth, August 14, 1845.[5]

Image at Right: The "Sophia Jane" being loaded with hay bales at the wharf at South Huskisson on Jervis Bay, NSW in 1843. The other ship is the barque "Cygnet".

This is a modern painting (imagined from contemporary sketches?) by Sydney marine artist Ian Hansen. No source provided.

Note the small expanse of what appears to be gaff-rigged sail she carried. She must have had a torrid voyage to Australia – via Brazil then Capetown to Port Jackson over 5 months. Reference see footnote 3.

1 The Australian, 20 May 1831, p3 – see http://nla.gov.au/nla.news-article36864964

2 ibid.

3 Maritime Heritage Association Journal Vol 23, No 1, March 2012, p14, *The Sophia Jane - Australia's First Steamship.* See: https://www.maritimeheritage.org.au/documents/MHA%20March%202012%20journal.pdf – a great story!

4 Edye Manning (1807-1889) - Australian Dictionary of Biography https://adb.anu.edu.au/biography/manning-edye-2427

5 Maitland Mercury and Hunter River General Advertiser, 16 Aug 1845 p3 see: https://trove.nla.gov.au/newspaper/article/675264?searchTerm=sophia%20jane

The Story of the Paddle Steamer SS Phoenix

Construction of the SS Phoenix

Edye Manning commissioned the construction of a replacement vessel for the *Sophia Jane* in about 1845. The hull was built by Thomas Chowne, a noted ship builder of the time with a yard at Pyrmont, Sydney.[6] The *Phoenix*' hull was launched in June 1846, and moved to John Struth's [7] wharf, on Darling Harbour at the foot of King Street, for fit out.

Launch, of the Steamer "Phoenix"

The launch of this new vessel took place yesterday morning, from Mr Chowne's ship-building establishment at Pyrmont, amidst a large concourse of Sydney folks, who had crossed over to witness the ceremony. She went off in beautiful style, and her model is the admiration of all who have seen her. Her deck length is 125 feet, with 21 feet beam, and her draught when loaded will be only 6 feet. Her cabins are fitted up with especial regard to comfort, particularly the ladies' department. Mr. Chowne is the builder of the "Phoenix", in the construction of which he has been left to his own unfettered judgment and has, we think admirably succeeded in combining the quality of speed with capacity of stowage, and light draught of water. The engineering work is in the hands of Mr. Struth, to whose wharf she will now proceed for the purpose of having her boilers fitted, &c. It is expected the "Phoenix" will commence running to the Hunter in the course of six weeks.[8]

Struth had recently set up a foundry business and was commissioned to cast the sole plate of *Phoenix* and fit her boilers and engine. The entire sole plate cast weighed in at 6 tons, far exceeding the previous casting record in the colonies of about 2 tons. . . . *Mr. Struth . . . charged his furnace, about ten o'clock am, with the metal to fill the moulds, and by half- past two the casting was completed, in such a way as not only did credit to him but to all those in his employ. The immense mass of solid metal was removed from the moulding bed by eleven o'clock on the following morning, and found to be all correct.*[9]

Struth reused the engine from the *Sophia Jane*, uprated it to 55 horsepower, and installed a new boiler system.[10]

A description from 1842 had said "… [*Sophia Jane*'s] engine is a beautiful piece of machinery …".[11] And that was when the engine was already 15 years old. Some more quotes, from soon after Sophia Jane was launched, attest to the engine's superiority. First – from *Bell's Life in London & Sporting Chronicle* of 30 March 1828:

The house of Barnes, Miller and Co., Glasshouse fields, Radcliffe, have constructed and fixed in one of their vessels, the Sophia Jane, steam-engine of fifty-horse power, which, [by] *a novel and effective arrangement of the machinery (the practical result of considerable skill and perseverance) is propelled with a velocity equal to a vessel of one hundred horsepower, and at the same time capable of transporting a similar burden.*

Then, from the *Waterford Mail Waterford, Ireland*, p3, of 5 April 1828:

The progress of improvement in steam navigation is unremitting. On Saturday (29 March 1828) the Sophia Jane, new steam vessel of [?] *tons burthen, made her third experimental trip* [to] *Gravesend, and performed various trials of her speed and powers, the whole of which were decidedly successful. The vessel is navigated by a single engine only, of but a fifty horse power, which works with such precision and effectiveness as to carry the vessel rapidly past others of considerably greater power, whilst the stability of the vessel is increased from its standing in the centre, and lower down in the hold, than where two engines are used—and, amongst other advantages, the weight, consumption of fuel, first cost, and liability to derangement, are very considerably diminished. The vessel is constructed, understand, by Evans, and the engineers are Barnes and Miller pupils* [of] *the celebrated Watt.*

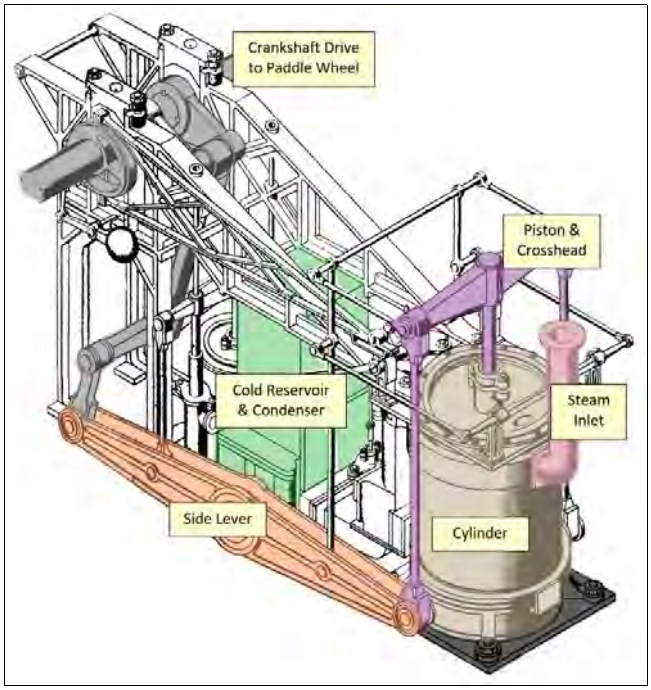


Image at Right: An isometric drawing of a typical side lever engine for a paddle steamer of the 1820s, adapted and simplified by the author from Plate XVIII in Thomas Tredgold, The Steam Engine – etc., Vol II, 1827.

6 Thomas Chowne (1801-1870), see https://www.wikitree.com/wiki/Chowne-17

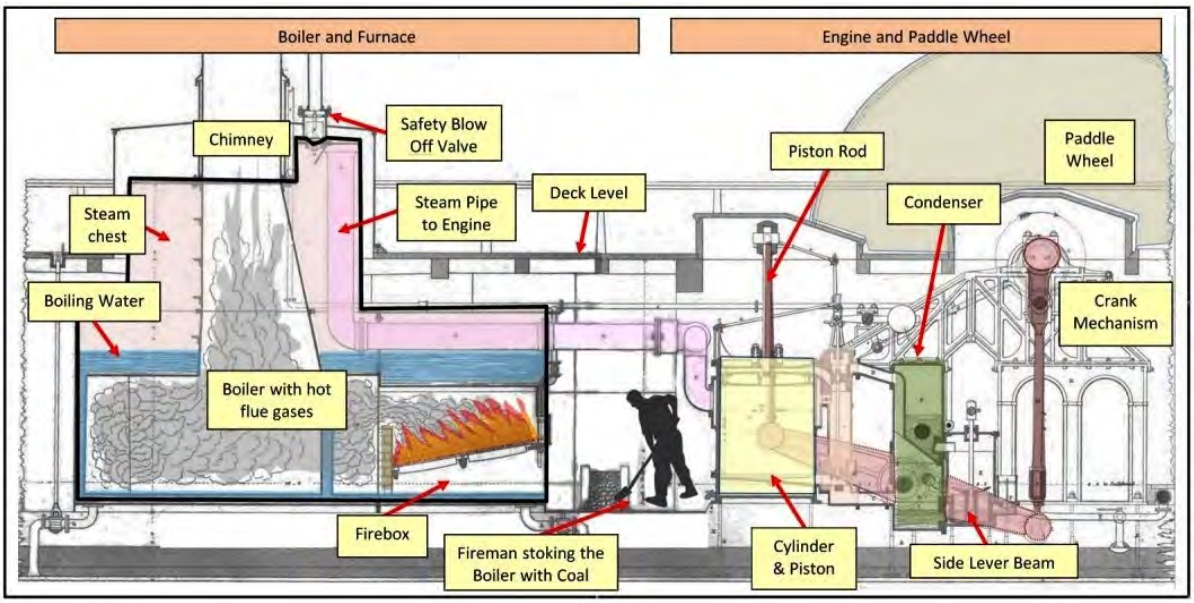
7 John Struth (1804-1886, see https://adb.anu.edu.au/biography/struth-john-2710

8 The Australian Journal (Sydney), 25 June 1846, p2, see: https://trove.nla.gov.au/newspaper/article/37159209?searchTerm=phoenix

9 Shipping Gazette and Sydney General Trade List, 2 May 1846, p126, see: https://trove.nla.gov.au/newspaper/article/161165116?searchTerm=phoenix

10 Stuart 1829 - *Descriptive History of the Steam Engine.*

11 Maritime Heritage Association Journal Vol 23, No 1, March 2012, p14, *The Sophia Jane - Australia's First Steamship.*



A sectional elevation drawing of a typical Boiler & Furnace, Engine & Paddlewheel, of a paddle steamer of the 1820s, adapted and simplified by the author from Plate XXXI in Thomas Tredgold, "The Steam Engine, its invention and progressive improvement," – etc., Vol II, 1827. Note how the side lever construction keeps the weight low, improving stability and freeing deck space.

The Phoenix' details were:

Built	Sydney 1845/46	Hull construction	– Thomas Chowne
Cost	£6000	Engine/boilers	– John Struth
Registration	Sydney 77/1846	Overall length	– 130 feet
Majority owner	Edye Manning	Keel length	– 105 feet
Capt and crew	about 10-16	Beam	– 19 feet 6inches
Cabins		Tons	– burthen/builders = 212 tons/108 tons
Saloon (men) – aft	16 Berths	Engine	– 55 horsepower
Ladies - aft	12 Berths	Engine type	– Side lever
Steerage - forward	14 Berths	Cylinder diameter	– 40 inches

Phoenix' Voyages

Her first test run around Sydney Harbour was on 15 Sept 1846, to much fanfare. *Phoenix*' maiden voyage, outside the Harbour, was to Wollongong on 6 Oct 1846. She entered service between Sydney and the Hunter a few days later.

On 10 Dec 1846, the Phoenix began regular journeys between Sydney and places on the far north coast of NSW, and Grafton, on the Clarence River, in particular. She proved to be reasonably reliable and trouble-free, apart from weather events. Fares were about £2. She was captained by Charles Wiseman.

> *COASTERS OUTWARDS. December 17.— "Phœnix", steamer, 108, Wiseman, for Newcastle and the Clarence River, with sundries*; . . .[12]

The Clarence Bar

The Clarence River Bar was notoriously difficult to navigate for shipping. A large river flow-rate constantly changed the sand shoals at the entrance. As well, there was a submerged reef to navigate and the tides also moved the sand around on a daily basis. Ships were sometimes 'bar bound' for days on end, until safe conditions prevailed. In fact, the Phoenix had been bar bound in the Richmond River, further north than the Clarence, for 2 months in 1847.[13]

12 Sydney Morning Herald, 18 Dec 1846, p2, See: https://trove.nla.gov.au/newspaper/article/12895453?searchTerm=wiseman%20phoenix

13 Sydney Morning Herald, 5 April 1847, p2, See: https://trove.nla.gov.au/newspaper/article/12892454?searchTerm=phoenix%20richmond%20clarence

The Story of the Paddle Steamer SS Phoenix

Feb–March 1850 - The Phoenix is bar bound inside The Clarence

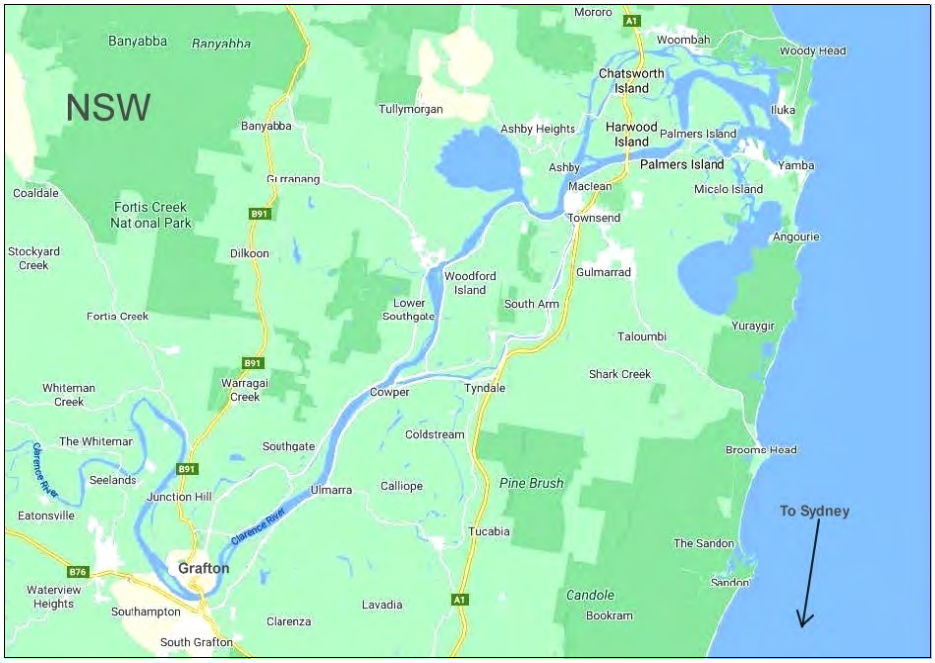
The Phoenix left Grafton for a return voyage to Sydney on 27 Feb 1850, but was bar bound for 4 days until the 3rd March. This was the Phoenix's 92nd voyage. A ferocious gale hit Sydney early on 2nd March and worked its way up the coast. At Newcastle … *We are informed that there has been a heavier sea off Newcastle during the last two or three days than has been known for some years* . . . Obviously, Captain Wiseman couldn't have known about the approaching gale force winds. About 11 am, on the 3rd March, the weather looked good, the swell had abated somewhat and the tide had just turned from high and was running out. He made the decision to 'cross out'.[14]

The Phoenix is Washed Ashore 12:30pm March 3rd 1850

At noon it blew a terrific gale, the steamer lost steerage way, and consequently fell off with her head inshore, drifting rapidly towards a low rocky point. (likely Angourie Point) The Phoenix had several mechanical problems with anchor chains. She *drifted into a small sandy bay,* (Angourie Back Beach, about 5 km south of the Clarence River). By 12:30, with some expert sailing, the Phoenix had avoided the rocks and was beached. The afternoon was spent getting the crew and passengers off. Fortunately, there were no fatalities, or even serious injuries.[15]

Detail from a map drawn by the Rev'd Coles Child when he went to Grafton in1850/51, showing the first Phoenix wreck location, 5 miles south of the Clarence River Mouth. Source: Mitchell Library File No. FL3788466.

The next few days were spent under canvas until passengers were sent overland to Yamba for pick up by the next available ship. Ironically, Edye Manning and his family were on board – bound for Sydney after inspecting his property near Grafton. He arrived in Sydney on the steamer *Eagle* on 20th March.[16]



Salvage

The *Phoenix* was not insured, and Manning and the other share holders put her up for auction "as is, where is." She was passed in, probably because the far north coast of NSW in 1850 was largely unexplored and far from facilities. Manning then decided to salvage her and sent "a party of men" to Angourie Back Beach. The men were Henry Manning (Edye's brother) , William West (foreman), W. Coleman, George Watson, James Dunban (incorrectly spelt as Dunbar)[17], and John West.

Image Left:
Part of north-east NSW showing Grafton (bottom left), Yamba and the Clarence mouth (top right) and the direction to Sydney. Grafton is 490 km from Sydney by air, but 660 km by water. Source: Google maps.

14 *The People's Advocate and NSW Vindicator*, 2 Mar 1850, p8: https://trove.nla.gov.au/newspaper/article/251537774?searchTerm=high%20water

15 *The Sydney Morning Herald*, 21 Mar 1850, p2 – *The Loss of the Steamer Phoenix*. See: https://trove.nla.gov.au/newspaper/article/12916580?searchTerm=loss%20of%20the%20steamer%20phoenix

16 ibid – also, top of the same column - *Shipping Intelligence - Arrivals* . . . Mr. and Mrs. Manning, four children & two servants, Captain Wiseman . . .

17 Personal communication

The boilers and engines arrived back in Sydney on 2 August 1850. The shipwrights remained at Angourie and repaired the sails and rigging, re-caulked the hull, and refloated her, by late May 1851. The *Phoenix* sailed into Sydney harbour under Captain Dare, on the 9th June 1851 and berthed at Struth's wharf. Over the next few months the boilers and engines were re-fitted and other repairs completed necessary to make her seaworthy.[18] The *Phoenix* resumed her service, leaving Sydney on the 20 November 1851, bound for Grafton. Alas, this *Phoenix* - the ship - was on borrowed time.

April 14th 1852 - The Phoenix is Stranded Again

About 3pm on 14 April 1852, the *Phoenix* was attempting to cross inwards on the notorious Clarence River bar. This was her 101st voyage. It seems that heavy rains had been falling for 3 days prior, and there was a heavy 'fresh' running out and the sand bars had changed since her previous crossing 9 days earlier. It is likely that the Clarence was in flood. *The strain* (of crossing the bar in a paddle steamer) *caused some of her machinery to give way at a very crucial moment*. The *Phoenix* drifted onto a sand bar north of the entrance, became stuck and had to be abandoned. All crew and passengers were got ashore safely.[19]

Auction of the Wreck

The wreck was deemed unsalvageable and the proprietors auctioned her "as is, where is" on 14th June 1852. A John Korff bought the wreck for £195. Korff was also a noted Sydney shipbuilder who had plans to recover the *Phoenix* from the sand bars on the Clarence River bar. However, this never eventuated and ownership of the wreck passed to his sons when he died.[20] The *Phoenix* wreck soon disappeared under the waves and shifting sand bars.

Occasional Exposure

Over the years, the *Phoenix* wreckage periodically appeared, but quickly disappeared again under the sand. A heavy sea in 1884 re-exposed her. *CLARENCE HEADS, SATURDAY. The recent heavy sea has unearthed on the north spit the steamer Phoenix, which was lost here some 33 a years ago. The old fashioned boiler, paddle wheels and engine are still in a good state of preservation. The hull is still coppered and people can walk around her at low tide. . . .*[21]

Korff's sons were forced to issue a caution to people not to remove any parts as it was still privately owned.[22] *STEAMER PHOENIX WRECK, CLARENCE HEADS. PUBLIC NOTICE. The undersigned, PURCHASERS of the wreck of the steamer Phoenix, stranded some years since at the Clarence Heads, do hereby CAUTION all persons from interfering with said wreck or any portion thereof, without authority from us, through our agent Mr WM. GEO. HART, Victoria-street, Grafton.* [Signed] *FREDERICK KORFF, GORDON KORFF. Dated at Sydney, 25th August, 1881.*

The last confirmed sighting of Phoenix was in 1918. *Mr. E W Blakeney (Stoker's Siding) recently spent a holiday, on the Clarence River, where many years of his youth were spent. At Yamba – at the mouth of the river he met an old friend who had quite recently been over the wreck remains of the old Phoenix, a little trading vessel that had met with disaster on the bar about half-a-century ago. . . . There are very few of the old Clarence River identities left who can remember the Phoenix, yet some of her spars and exposed ribs are to be seen just outside the break in the surf.* [23]

Magnetic Anomaly Located

In 1993, the University of New England surveyed the beach immediately north of the Clarence River heads.[24] They located a magnetic anomaly under the sand. It is quite possible that this was the remains of the Phoenix's ferrous metals, that is, in particular, the steel boilers and sole plate.

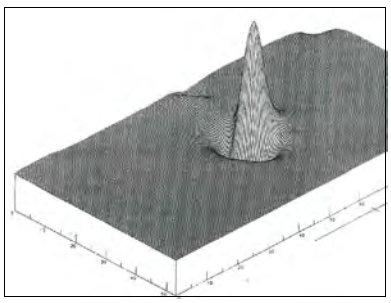


Image at Right: One of the University of New England's Magnetic Anomalies discovered on Iluka Beach in 1993. Source: UNE 1993 Report No. 9337.

18 Stuart 1829 – *Descriptive History of the Steam Engine.*

19 *The Sydney Morning Herald*, 5 May 1852, p2 – *The Loss of the Phoenix.* See: https://trove.nla.gov.au/newspaper/article/12936496?searchTerm=loss%20of%20the%20phoenix

20 *Maitland Mercury & Hunter River General Advertiser* 19 June 1852 – *The hull and machinery of the Phoenix were sold by Mr. G. A. Lloyd, at auction, yesterday, for the sum of £195, to Mr. J. C. Korff.*— https://trove.nla.gov.au/newspaper/article/667759?searchTerm=george%20a%20lloyd

21 *The Sydney Morning Herald*, 4th Aug 1884, p3

22 *Clarence and Richmond Examiner and New England Advertiser*, 30 Aug 1884, p5

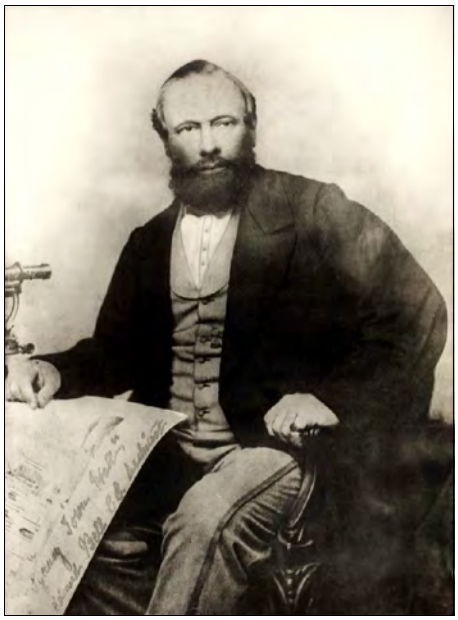
23 *The Tweed Daily*, 2 Sept 1918.

24 University of New England 1993 - Report No. 9377 – *Search for the SS Phoenix.*

Edward Bell, Sydney City Engineer 1856 to 1870.

By Dr Jennifer Preston, FRAIA.

Dr Preston is a Sydney architect and the Chair of the Australian Institute of Architects Heritage Committee, NSW Chapter. She would like it to be known that some of the technical and engineering details in this story were contributed by Carl Doring, B.E (Mech). – Editor.



Mr. Edward Bell, M.I.C.E., 1861, from the Bell Family Papers, Mitchell Library, SLNSW A2531.
Photographer unknown.

Introduction

In 1842 Sydney was incorporated as a city and one of its responsibilities was the supply of water to homes, but by1844 only 72 houses had been connected to a piped supply and the council's inability to provide an extensive water supply was a major factor in the sacking of the council in 1853. The council was reinstated in 1856 and the most daunting issues they faced were water supply and sewerage. In addition, there was a great deal of work required on roads, kerbs and gutters, pedestrian connections, public drinking fountains and the construction of buildings. The city needed an engineer.

Edward Bell was an English trained civil engineer who was already widely experienced before arriving in Sydney with his wife Mary and eleven children on 25 January 1856 on the ship *Joshua*, with Master John Fowler.[1] He was appointed to the position of City Engineer almost immediately.[2] Bell had been born and educated in England serving *his articles working on the drainage of fens and on municipal water supplies in Britain and Holland* and his career had *a particular focus on drainage, water provision and sewerage works* in several countries.[3]

Thornton Obelisk 1857

One of Bell's early challenges was the development of Sydney's sewerage system, and as part of this Bell incorporated a vent shaft disguised as a grand obelisk. Named after the then Mayor George Thornton, this remarkable obelisk is now one of the oldest extant items of infrastructure connected with the city's sewerage system, and unquestionably an urban design element within the city.

A vent shaft had been proposed by the City Commissioners after the council had been sacked by the colonial government. Plans for the ventilation shaft and the Bathurst Street sewer were signed by Bell in March 1857 and the construction was completed by the Council. The proposal for the ventilation shaft had been presented in the second meeting of the City Council's Sewers Committee where it was resolved that the City Engineer would forward the necessary plans and specifications.[4]

Ventilation Shaft, Erected A.D. 1857 George Thornton Mayor, City of Sydney.
City of Sydney File 067/067207, A268.

It seems to have been Bell's idea to create the ventilation shaft in the form of an obelisk with a design based on Cleopatra's Needle, which had been a gift to Britain by Mehemet Ali, ruler of Egypt and Sudan, as a commemoration of the victories of Nelson at the Battle of the Nile and of Sir Ralph Abercrombie at the Battle of Alexandria in 1801. Although Cleopatra's Needle was gifted in 1819, due to the very significant problems of transportation to England it did not arrive in London until 1878.[5] Bell would not therefore have seen it in London before he left for Australia but probably viewed it in Egypt before it was shipped when he worked in Alexandria between 1837 and 1840.

1 See: http://marinersandships.com.au/1856/01/082jos.htm

2 Appointment of Edward Bell, 12 February 1856, Item 0025/8, Letters from Colonial Secretary, City of Sydney Archives, *Empire*, Feb. 13, 1856.

3 Institute of Civil Engineers, *Memoirs*, Minutes of Proceedings, Volume 42, Issue 1875, 1875.

4 Sydney Water, Heritage Item 4571022 Sewer vent (The Obelisk) http://www.sydneywater.com.au/Sustainability/OurHeritageAssets/_item_view.cfm?hi=4571022 Accessed 18/02/2013.

5 Rev. James King, *Cleopatra's Needle: The History of the Obelisk with an exposition of the Hieroglyphics*, (London: The Religious Tract Society, 1893), 41.

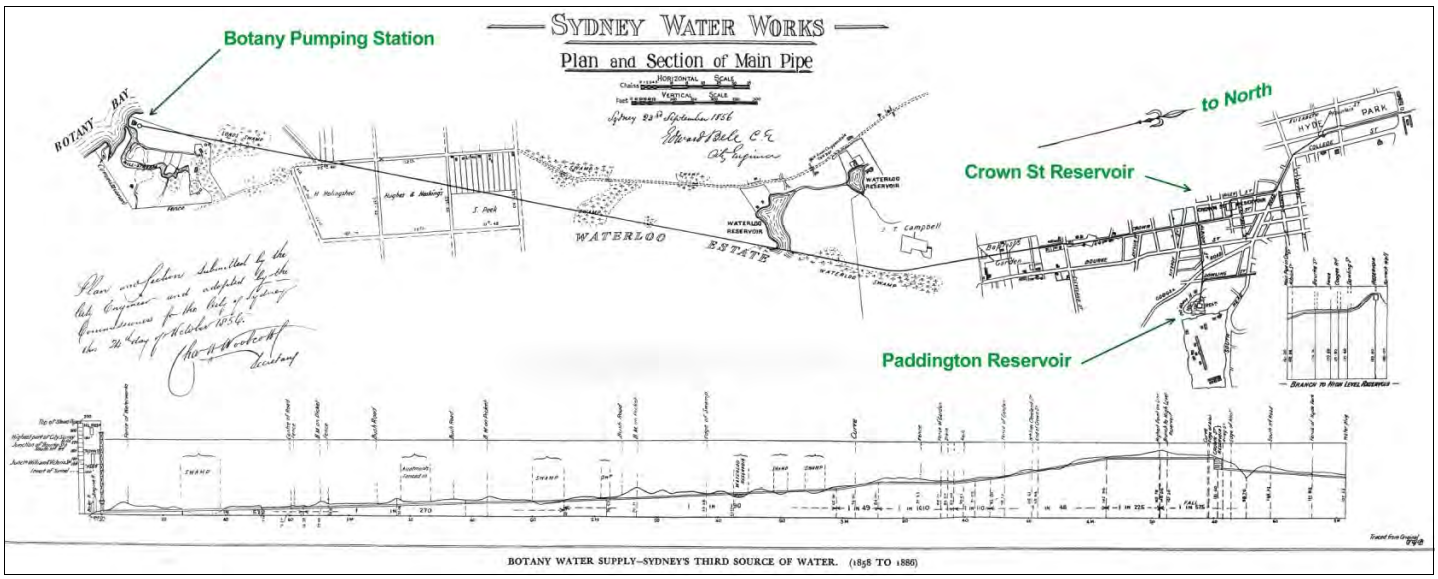
Bell described the design of the Sydney obelisk in a letter to the town Clerk: *the ventilating shaft … will be in the form of an obelisk (75 feet high) and will occupy a space of 15 feet square. It will stand 15 feet distant from the alignment of the Park, facing Bathurst Street, and from the ornamental character of the design will, it is considered, be an improvement and be no impediment to recreation of the Public while it will conduce much to the health of the inhabitants of the City.*[6]

The sandstone base with Egyptian styled sandstone carvings of sphinxes and asps that decorate the junction of the base with the rendered masonry shaft, and the decorative bronze ventilator that caps the obelisk, make this the most decorative of all the city's sewerage vents.

The siting of the vent was also an important consideration. Bell located the vent at the highest point of both the sewers and that section of the Sydney topography.[7] In doing so he created a focal point for the eastern end of Bathurst Street so that the obelisk addressed one of the axial vistas of the town and contributed both to the streetscape of Elizabeth Street and the amenity of Hyde Park.[8]

Sydney's Third Water Supply Scheme

Sydney had been plagued by droughts since the first days of the colony. In 1853 William Rider, the then City Engineer, was asked to prepare a design for a water supply scheme centred on two existing ponds on land owned by Simeon Lord – Mill Pond and Engine Pond, at Botany, close to the site of the present Sydney Airport.[9]



Sydney Water Works Plan and Section of Main Pipe. Edward Bell, 1856. From F. J. J. Henry "The water Supply and Sewerage of Sydney", opposite page 48

Rider prepared designs to pump water from the dams on Simeon Lord's land to a mid-level reservoir in Crown Street Surry Hills, with an additional high level reservoir planned for a future site at Paddington. Rider's plans were elaborate, expensive and had serious design flaws. The manufacturers of the engines that were to pump the water, Thomas Perry and Son of Bilston, Staffordshire, England, found the design and documentation so poor that it was *impracticable to execute the designs*. However they had a contract to supply and in order to avoid being in breach of that contract consulted *one of the highest authorities upon hydraulic engineering in England.* That person was probably Thomas Hawkesley, C.E., M.I.C.E., an English civil engineer who had a significant role in many of the major water supply schemes in Britain.

At the same time as the manufacturers were seeking advice from Hawkesley, Edward Bell had reviewed Rider's documents, concluded that they were *absurd and impractical* and had, with the agreement of the City Commissioners sent word to England to stop the manufacture of the engines designed by Rider.[10]

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6 Colonial Secretary, 1857-1859. Item 0025/9, City of Sydney Archives.

7 Ibid.

8 Sydney Water Heritage Item 4571022 Sewer Vent (The Obelisk) https://www.sydneywater.com.au/SW/water-the-environment/what-we-re-doing/Heritage-search/heritage-detail/index.htm?heritageid=4571022

9 F. J. J. Henry, *The Water Supply and Sewerage of Sydney*, Sydney: Metropolitan Water Sewerage and Drainage Board, 1939, 49.

10 Edward Bell, *Botany Water-works*, *Sydney Morning Herald*, 21 Dec 1857, 3. See: http://nla.gov.au/nla.news-article13004159

Edward Bell, Sydney City Engineer 1856 to 1870.

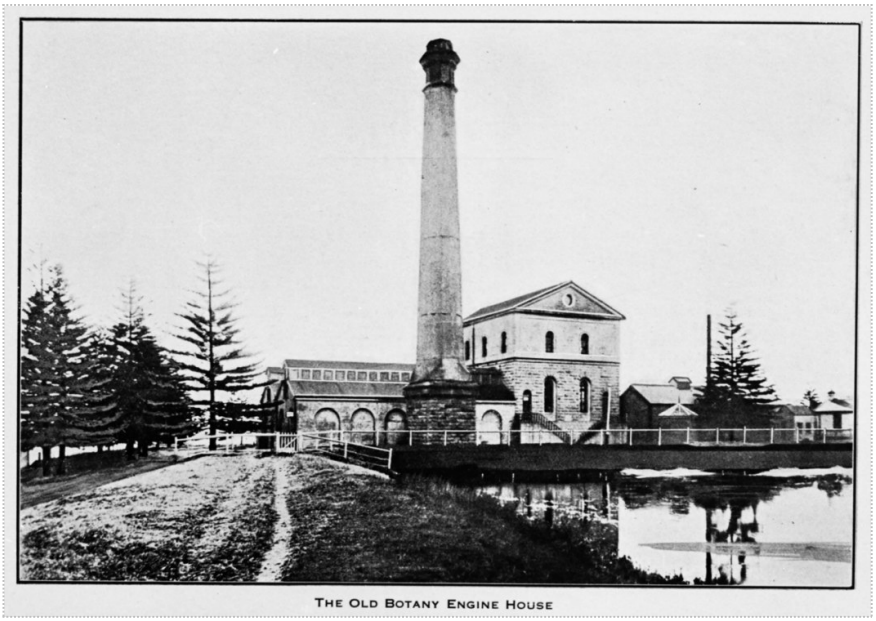
In a report to the City Commissioners' Office, dated 28th March 1856, Edward Bell wrote: *On receiving this contract for approval, I observed that the duty the engines were required to perform was not stated, and the diameter of the pump was not given in the specification or plans; and immediately wrote, by permission of your Board, to Mr S. C. Homersham, C.E., M.I.C.E., to inspect them before shipment; and authorised him, in the event of him finding the engines incapable of raising each 1,500,000 gallons per day a height of 210 feet, to grant a sufficient extension of time to make them so, under his direction.*

Working on the basic principles established by the Governor's Board of 1852, Bell developed a new design for the pumping station, a traditionally English design with most of the machinery and components imported from Britain. The heart of the scheme that became *The Botany Pumping Station* included an engine house, boiler house, chimney, workshop, pipeline and reservoirs as well as a new wharf constructed nearby for delivery of the coal to fire the boilers.

The Botany Pumping Station

Bell's design located the pumping station on the site of Simeon Lord's former flour mill where the bedrock was accessible for the foundations required to support the heavy beam engines.[11] The pumping station's foundation stone was laid in December 1857 and the station was operational within two years.[12]

The principal buildings erected at Botany were the boiler house and engine house and a 142 foot high chimney. The engine house was built of stone from the George's River area and measured fifty feet by forty feet. It was two storeys high with ironbark beams, but despite the native timber it *was representative of English practice of the day*.[13]



The Botany Pumping Station viewed from SE, from the Engine Pond dam wall, c1890 – then disused, but still intact.. At left is the Boiler House and its chimney, then the 2-storey Engine House. The photo was published in a 1918 Commemorative Volume for the Sydney Water Board.

Upper floor of the Engine House, viewed from SW to NE., showing the 3 large, cast-iron rocking beams. The 3 steam cylinders are on the floor below, with steam pistons connected to the south (RH) ends of the rocking beams and pump pistons connected to the north ends Photo from Sydney City Archives, Sydney Water Collection A-00069858.

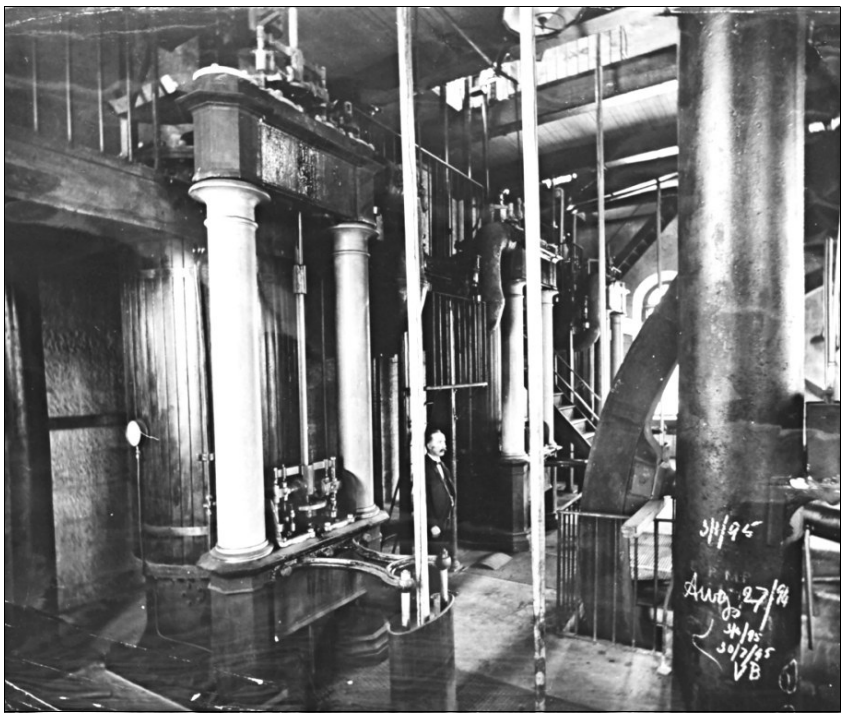
There were three pumping engines, but the central and eastern engines (far - in photo at left) were linked together by a shared flywheel and flywheel crankshaft, and acted together as one pump. The western engine (near - in photo at left) had its own flywheel and acted independently. Rider's initial design called for three 75 horsepower engines, but under instruction from either Edward Bell or Mr Homersham their power was increased to 100 hp each. The engines were much discussed and reported on often in some detail. *To give some further idea of the size of the engines we may state that the beams are 24 feet in length, which is also the diameter of the fly wheel; the ring of the latter, without the arms, weighs 19 tons 16 cwt; its entire weight is 36 tons. At the rate of twelve strokes a minute one of the engines would fill the main in 4½ hours, two would fill it in 2¼ hours, and three in 1½ hour. The width of the cylinder is 42 inches.*[14]

11 NSW Legislative Council 1869, *Report of the commission appointed to enquire into the supply of water to Sydney and Suburbs*, NSW LC Jnl, Vol.17, pt.2; Noel Thorpe Water Supply and Sewerage; Sydney Water, *Botany Wetlands Conservation Management Plan*, Sept. 2003, p19.

12 Botany Wetlands CMP p20 Sydney Water.

13 SMH 10 March 1859, 5; Heritage Impact Assessment, Brooks 2001 19.

14 *The Botany Water Works*, SMH 10 March 1859, 5.



All 3 steam cylinders, viewed from E to W, at operating floor level (ground floor), probably photographed c1896, just before the pumps and engines were removed. Note the figure at the centre giving scale. From SCA - Sydney Water Collection & Water Board HRU Photo A428.

The three massive single cylinder vertical steam pumping engines made by Thomas Perry and Sons, Staffordshire, were shipped to Australia and installed at the pumping station in 1858. The engines were unique in the colony and were representative of the last generation of beam engines.

The photograph at left shows the eastern pumping engine's steam cylinder (left foreground, with vertical wood slat cover), and the linked central engine's steam cylinder (middle) with shared a flywheel between them (mid-right). The bottom half of the flywheel turned in a semi-circular pit in the floor. The stand-alone western engine's steam cylinder and its flywheel are in the far distance, just visible. Part of the central and western rocking beams are visible above. The big column at right supports the centre pivot of the rocking beam above. Vertical rods at the northern ends of the rocking beams operate the pumps, sunk in pits underground.

The engine's steam cylinder has Fairbairn drop valves that admit steam to the bottom and top of the cylinder alternately, to provide motive power on both the up and down strokes of the steam piston. The visible part of the valve gear includes the means to select the point in the engine cycle at which the steam supply is stopped. This feature improved efficiency by making use of the continued expansion of the steam after it had been cut off.[15] To prevent the condensing of steam due to cool air on the outside of the steam cylinder the cylinder was first covered with a coarse woollen fabric and then encased in polished cedar slats.

A different view of Botany Pumping Station, with Engine House (centre), Boiler House (right), and Workshops (left), viewed from the west c1896. Seen along the north side of the Engine House are the three iron air vessels, which cushioned the pulsed output from the pumps. Sourced from Water Board HRU Botany Sewage Farm File c1995.

Reciprocating piston pumps like those at Botany and most pumping stations of the time produce pulses of water. Long delivery pipes, such as from Botany to Crown Street Reservoir, contain a large body of water which has a lot of inertia and wants to flow at a steady speed. Water does not compress, so this mismatch could create damaging pressure spikes where pump meets delivery pipe. The traditional English method for smoothing out the pressure pulses of each pump, until the 1850s, was the use of a tall open-top standpipe connected just after the pump, allowing water in the standpipe to rise and fall with each pump cycle, with the average gravity head of water in the standpipe matching the average delivery pressure in the delivery pipe, which had to well exceed the head of water in the receiving reservoir. A standpipe appeared in Bell's early designs,[16] but he subsequently replaced the standpipe in the design by three large pressure vessels half-filled with pressurised air which cushioned the delivery pulses from the three pumps.[17]

15 https://collection.maas.museum/object/212334

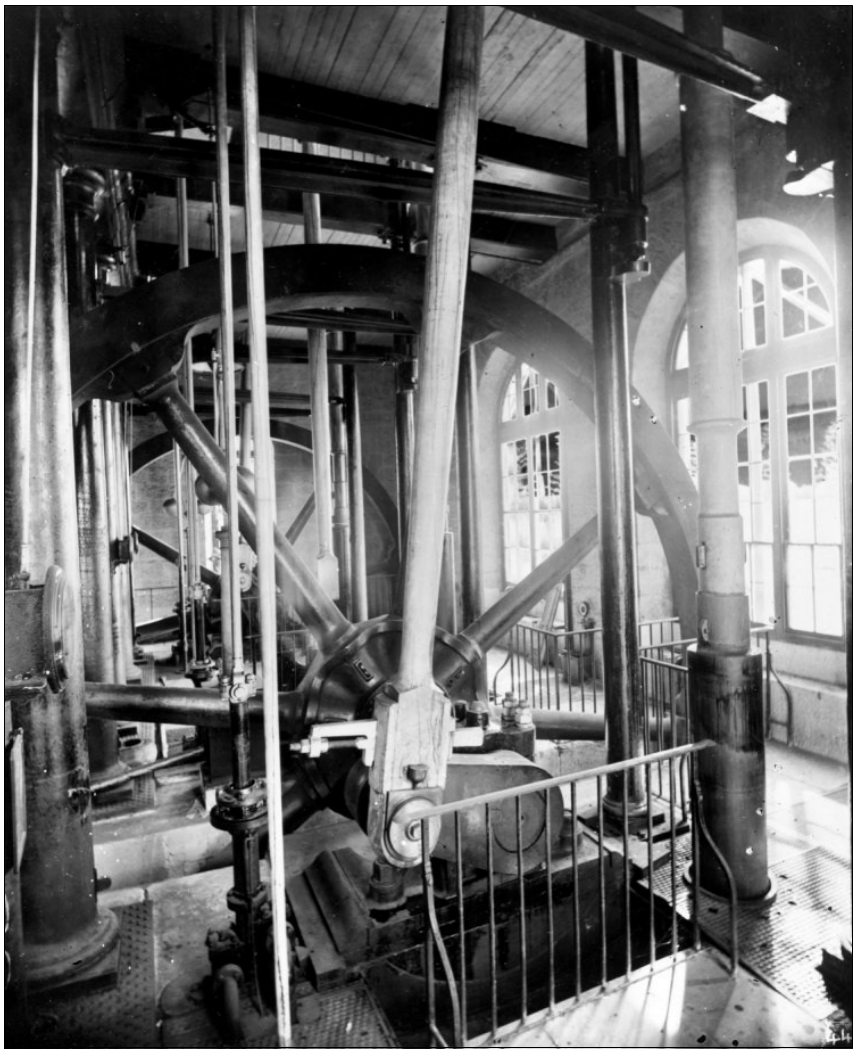
16 Edward Bell's drawing of the scheme dated 23rd September 1856.

17 Noel Thorpe *Water Supply and Sewerage, Sydney from Settlement to City*, Don Fraser, ed., Sydney: Engineers Australia 1989, p21.

The pressure vessels were one of Bell's technological improvements. Such pressure vessels had only recently been used in England and Bell, clearly aware of the latest English technology and in communication with engineers there, modified his design to utilise pressure vessels.

The machinery had several later improvements, including a counter whose dial plate indicated the number of revolutions (not identified). The pumping engine steam cylinder of one of these engines is held in the collection of the Museum of Applied Arts and Sciences in Sydney.

Image at right: The pumping engine steam cylinder, with Fairbairn drop valves, from one of the three pumping engines originally at Botany. This steam cylinder was saved from the clearance of the closed down Pumping Station and donated to the then Technological Museum of Sydney at the former Sydney Technical College in c1897, 40 years after it had been installed at Botany. This photo was sourced from the Museum of Applied Arts and Sciences (MAAS) in Sydney, where the steam cylinder is now held.



Another view of the pumping engines at the Botany Pumping Station, looking east to west and showing the flywheels and crankshafts etc. at the north end of the operating floor. Further description of this image is in the text.
Source: City of Sydney Archives, SRC2906 Sydney Water Collection A-00069856.

The image at left shows the north half of the engine house interior, viewed from east to west.

In the foreground is the large flywheel and flywheel crankshaft shared by the eastern and central pumping engines, thus linked together to act as one engine.

At left foreground is one of two iron columns supporting the east rocking-beam's central pivot bearings (above).

At right foreground is the connection between that end of the rocking beam to the eastern pump, located in a pit below.

At centre foreground are the conrod and crank connecting the east rocking beam to the shared eastern flywheel (behind). In mid-ground are parts of the linked central pumping engine. In far background is the flywheel etc. that served the independent western pumping engine.

Image at Left: The six boilers – two each for the three pumps – at Botany Pumping Station c1896. Source: City of Sydney Archives, photo Sydney Water Collection A-00069871

The boiler house was also built of stone, but just one storey high, measuring 76 feet by 50 feet. It contained six Lancashire-style boilers, each 7 feet in diameter and 36 feet long, and each having two fire-tubes or fire-boxes. Stokers shovelled coal in at the rectangular openings with small twin doors, and scraped ash out at the semi-circular openings underneath. The white insulated overhead pipe took steam from the boilers to the pumping engines.

It is likely that photographs of the Botany Pumping Station interiors were taken in 1896, when the long-disused Botany pumping engines and boilers were sold at auction and were about to be removed.

Crown Street and Paddington Reservoirs

The Botany Pumping Station was connected to the mid-level reservoir at Crown Street in Surry Hills by the thirty inch iron main manufactured by P. N. Russell & Co. of Sydney. The Crown Street reservoir still exists and is still in full operational use although the three and a half million gallons of water it contains today comes from the Nepean water supply system rather than from Botany. The reservoir is located 139 feet (42.4m) above sea level and the original design by Bell was also a typically English design in most respects.[18] Construction commenced in 1857 and the structure was built partly in excavated rock which was sealed with bitumen and partly on fill with the floor in brick. It was divided into two equal parts and constructed with brick walls that were faced with approximately 300,000 impervious glazed bricks imported from England, up to the waterline.[19]

Crown St Reservoir is under the grass in the foreground, reservoir buildings in the background, and characteristic loads of plumbing fittings in rows on the grass. Over the years, the roof carried heaps of coal for the boilers, or large numbers of cast-iron valves, without any damage to the structure.
Source: Water Board HRU photo A1157 c1893.

The roof structure comprised brick jack arches supported on cast iron fish-belly girders, set upside down so the bricks rested on a straight bottom flange. The girder ends in turn were supported on 170 ironbark columns, each twelve inches square, with cast iron column caps. The cast iron cross stays of the brick jack arches followed the shape of the arches.[20] All the cast iron was imported from England by Rabne Feez and Co. of Sydney.

Image at Left: The interior of the reservoir photographed in 2009. Shows ironbark columns, upside down fish-belly girders and brick jack arches.
Source: Sydney Water Corporation, Heritage Collection, uncatalogued.

18 T. J. Roseby, *Sydney's Water Supply & Sewerage, 1788-1918*, Commemoration Volume, Metropolitan Board of Water Supply & Sewerage, 1918, 23

19 Thorpe, 21.

20 Thorpe 21, Sydney Water, Crown Street Reservoir (Covered) (WS 0034) and Site.

The brick jack-arch was developed in England towards the end of the eighteenth century, primarily as a means of fireproofing multi-floor mill construction. In an article about the origin and use of the jack-arch in New South Wales, the conservation architects Sean Johnson and Ian Stapleton claim that *its first use in Australia was at the Old Treasury Building, Melbourne* which was constructed between 1858 and 1862. The Crown Street Reservoir was complete with its jack arched roof sealed with tar and covered in puddled clay in 1858. It was then further covered in soil and sown with grass. It had three tall, rendered brick ventilation shafts.[21] The reservoir was in service by 1859. It is therefore almost certain that the Crown Street Reservoir was the first use of the jack-arch in Australia.

Detail of the interior of the Crown St Reservoir roof, showing an ironbark column, cast-iron column capitals and brick jack arches supported by the cast-iron girders. The dark lines following the curve of the jack arches are the underside of the cast-iron cross stays. Photo C. Doring, 1991.

Another 'first' for the Crown Street Reservoir was the load testing of its beams. The cast-iron beams were individually load tested to 50% greater than the expected load prior to construction, a new practice in Australia at the time. The order from Australia specified that the English-made cast-iron beams must be individually proof-tested in England, prior to being shipped to Australia. An agent of City of Sydney (possibly Mr S.C. Homersham, who had also been engaged to fix the Botany engines and to check cast-iron pipes for the project) had to witness the proof test loadings of the beams. The practice was first used in England only six years earlier for the construction of the Crystal palace in London in 1851. Not all the construction technology was English. English practice of the time would have supported the beams on cast-iron columns. In the Crown Street Reservoir and the later Paddington reservoir, Australian hardwood ironbark columns were used.[22] Many of these are still in existence at both reservoirs, 150 years later

Initially the Crown Street Reservoir fed water via gravity to properties at lower levels of the city and suburbs but in 1879 a pumping station was completed at Crown Street to pump some of its water up to the higher Paddington Reservoir, serving some eastern suburbs. The first stage of the Paddington Reservoir was built between 1864 and1866. It was expanded in 1873, but decommissioned in 1899. It is a large rectangular structure, constructed of brick with jack-arch roof and supporting timber columns, partially subterranean with a grass cover on the roof. It remained almost unseen when used as a reservoir. Later, the disused reservoir became an underground car park, but that involved removal of or damage to some timber columns and in 1993 part of the roof collapsed. It is now used as a semi-open sunken park or garden.

Paddington Reservoir Gardens, 2009. Photograph Ross Thornton.

The photograph at left shows the Paddington Reservoir Gardens with its timber posts with cast-iron caps supporting some now-exposed fish-belly cast-iron beams (belly-side up) that in turn supported the semi-circular brickwork jack arches of the roof. A few intact jack arches can be seen above the centre of the photo. The jack-arch roof originally covered the entire reservoir and, like Crown Street Reservoir, was in turn covered with a shallow layer of earth and a flat expanse of grass.

The combination of technologies used in the Crown Street and Paddington Reservoirs proved to be unique, as later reservoirs at Woollahra, Waverley and Petersham used brick columns to support their brick jack-arched roofs.[23]

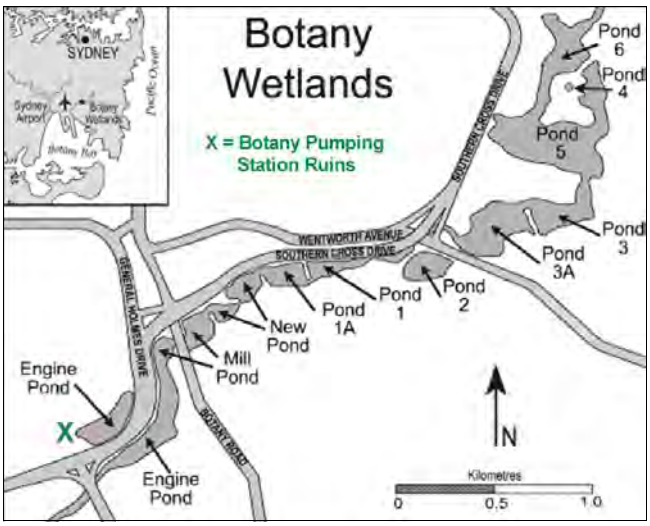
21 Sydney Water, Crown Street Reservoir (Covered) (WS 0034) and Site.

22 Sydney Water, *Crown Street Reservoir and Site Conservation Management Plan*, May 2004.

23 ibid.

The Botany Dams

Although the water supply had not failed during the early years of the Botany pumping station's operation, the inadequacy of water storage at the lower pumping station end of the scheme which relied principally on the Engine Pond made it necessary to turn off the water supply at night. In 1866 a reliable water supply was a regularly discussed topic again in the newspapers. In 1866-7 Bell prepared plans and specifications for six additional ponds (Nos.1-6) between Mill Pond and Gardeners Road, along the line of Mill Creek, and work began in 1867.



The Botany Wetlands pond system drawn c2002 for a research paper. The Mill Pond and ponds Nos.1-6 survive basically as Bell left them. The Engine Pond has had the enormous General Holmes Drive driven right through the middle of it. The mill stream flowed from swamps at top right (NE) towards Botany Bay (SW) Source: researchgate.net

The dam walls were constructed of a framework of timber beams that were bolted together with iron bolts and closely fitted vertical planks were fixed to both sides of the frame. Two of these frames were then sloped outwards in opposite directions and the space between filled with fine silt mud or bog and sand.[24] The dams were built between high natural sand banks that bordered the stream. The dams were covered in couch grass and were raised 14 feet above the swamp level. A weir of eight feet above swamp level was inserted to accommodate flood overflow. A sluice was centred along the watercourse in each dam.[25]

The lower three dams were built first. Bell also erected a puddle wall to protect the Engine Pond dam better from salt ingress. A further series of dams (Nos. 7-13) were planned but never eventuated.[26]

Edward Bell resigned from the council in 1870 after queries about the reliability of the water supply and accusations of incompetence. However, reading the archive material gives the impression of a man who was overworked, stressed, has been let down by people he trusted and who feels undervalued, rather than one who was incompetent. He was succeeded as City Engineer by a Francis Bell, who was not related.

The years that Edward Bell worked as the City Engineer and City Surveyor had seen Sydney grow from a small and simple town into an increasingly populous and complex city. Edward Bell was instrumental in the provision of the city's essential water supply and sewerage systems and added significantly to the public realm through the design of public amenities, circulation infrastructure and buildings, a significant portion of which still survive.

Not the least of the survivals are the archaeological ruins of one of Bell's major works – the Botany Water Pumping Station. On the left in this Google Earth image from 2018, we see the tiled roof of the much later Botany Sewage Pumping Station. Just to its right (east) we see the excavated operating floor level of the Engine House. It was exposed and the pump pits cleaned out in 1995. Along the outside of the north wall are the 3 base plates of the 3 pressure vessels. Due south of the Engine House are the remains of the tall chimney (partly demolished as a danger to aircraft). To the left of the chimney, the Boiler House is hidden under a big fig tree. The Engine Pond is to right of the chimney. – Ed.

24 SMH 24 June 1867; W. V. Aird, *The Water Supply, Sewerage and Drainage of Sydney*, Sydney: Metropolitan Water Sewerage and Drainage Board, 1961, 11; F. J. J. Henry, *The Water Supply and Sewerage of Sydney*, Sydney: Metropolitan Water Sewerage and Drainage Board, 1939, 49.

25 NSW Legislative Council 1869; Q 1342

26 Botany Wetlands CMP p 23

Engineering Out an Epidemic
or Rediscovering a Perth "Foundation Stone"

By Perry Beor

Background

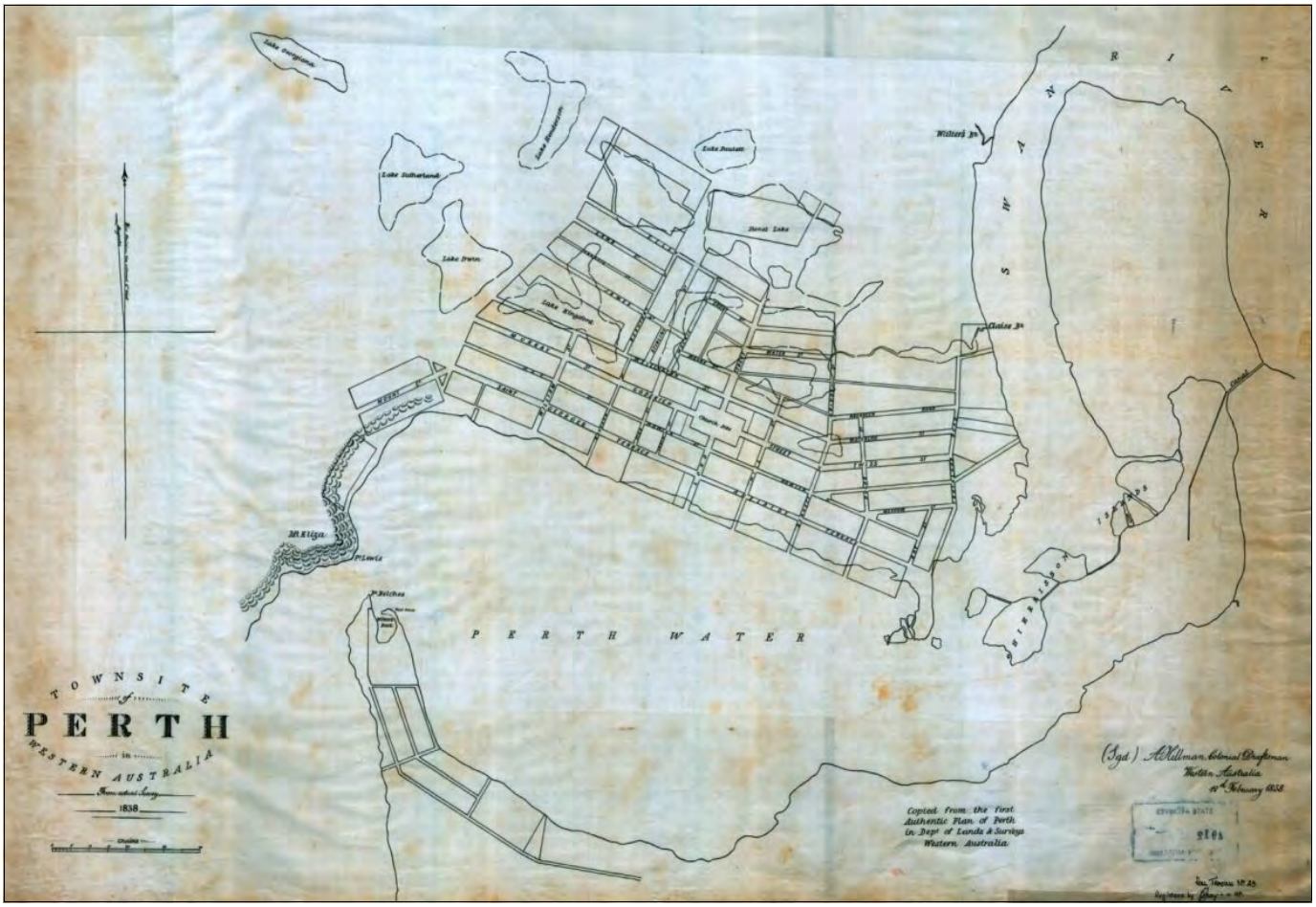
Recently a major piece of turn of the (20th) Century engineering was rediscovered 5 metres below the streets of East Perth. It reflects the time of an early epidemic to hit Western Australia and the engineering solutions found to defeat it.

Perth Location

The township of Perth was founded in 1829, on a low sandy spur, approximately 15 metres high, 500 metres wide and 3km long, and it was 12 miles (20km) upstream (up the Swan River) from present day Fremantle. To the west there was a high limestone ridge – now the home of Kings Park – before one reaches City Beach and the Indian Ocean. To the south and east was the Swan River. To the north there were a series of 10 or so freshwater lakes and lagoons which drained into the Swan River.

The Freshwater Lakes and Convict Drainage

Unfortunately, most of these lakes were shallow and during the hot summer of 1833 they dried up, leaving the settlers to depend on shallow wells and a few springs. It was apparent even in those days that while a number of the larger lakes reflected the more traditional concept of a lake as being a permanent water source, the majority of the smaller lakes to the north of Perth were (as described in 1873, in *The Inquirer and Commercial News)*, *marsh and bog, producing foetid unwholesome miasma, all year round.*

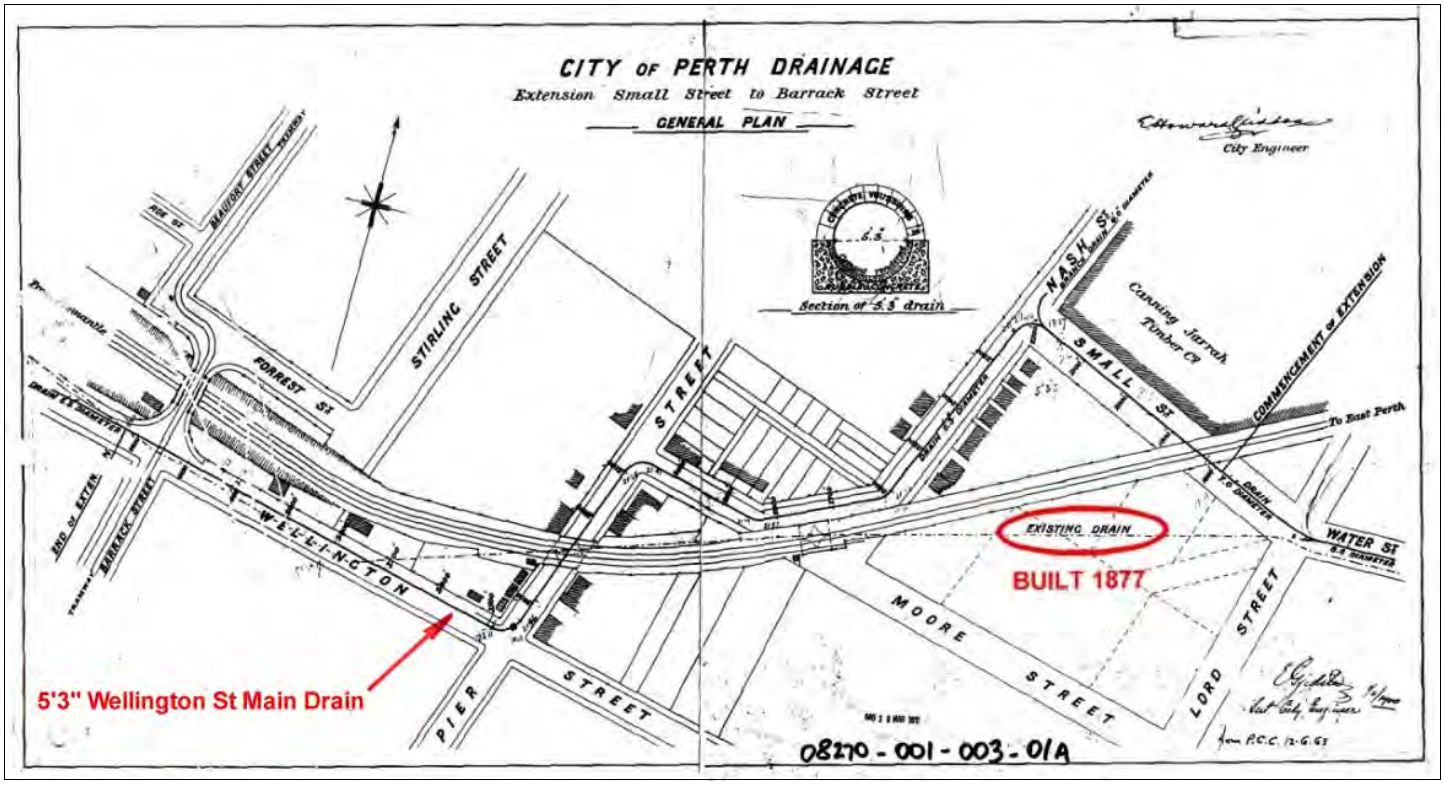


Portion of an 1838 plan of the original Town Site of Perth WA. The street grid is much the same as the modern CBD, with St Georges Terrace and Adelaide Terrace running along behind the waterfront of Perth Water (or the Swan River). Kings Park (Mt Eliza) and the limestone ridge are to the west of the street grid, and the Indian Ocean is further west and off the map. The Claise Brook, towards the north of the street grid, drains the Freshwater Lakes into the Swan River at right. Source: WA State Archives.

Engineering Out an Epidemic

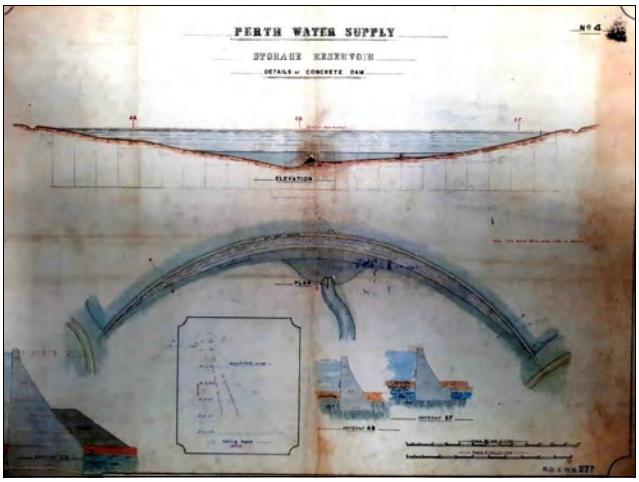
Development of Perth to the north was hindered by the presence of these lakes, which often flooded in winter months – as Lake Kingsford did in 1847. The following year a paper by the Colonial Health Committee found that the lakes were a direct influence on disease in Perth and recommended that a permanent drain be constructed. This was completed by convict labour in August 1848 and drained an area encompassing the current CBD into Claise Brook which discharged into the Swan River to the east of Perth.

By 1854 it was found that these drains were insufficient and two Royal Engineer Lieutenants – Crossman and Wray – were commissioned to examine the drainage of the lakes. They recommended constructing a new drain of considerably greater capacity. Following further flooding over the next four winters, these works were considerably increased in capacity. Even these measures were insufficient to avoid further flooding in the 1870s and an entirely new drain was constructed in 1877.



1900 Plan of East Perth showing the location of the new 5 feet 3 inch diameter Wellington St Main Drain and the route of the original 1877 convict built drain. The drawing is signed on 1/11/1900 by E.H. Glidden, City Engineer and E.G. Jedsted, Assistant City Engineer, whose names appear on the "Foundation Stone". Source: Water Corporation.

The residents of Perth still had to get their water from somewhere and most of it was sourced from private wells, many of which were polluted by adjacent cesspits. This was noted as early as the 1880s by the Colonial Surgeon Dr Waylen, whose 1893 report found that, *fever and diphtheria may be looked upon as endemic diseases in Perth and Fremantle fostered by sewage contamination of air and water.*



1890 plan of the newly completed Victoria Dam on Munday's Brook. This photo was used in an Oct 2012 Engineering Heritage Marker booklet. Source: Water Corporation.

In 1885 a Sanitation Commission was established, which called for the removal of all cess pits, to be replaced by a night soil scheme and for the creation of a clean water supply scheme for Perth. This scheme was eventually completed in 1890 and consisted of:

- An Impounding Reservoir on Mundy's Brook (Victoria Dam) of 240,000,000 gallons (1.09GL);
- A Service Reservoir on Mount Eliza (in Kings Park) of 643,650 gallons (2.9Ml); and
- 1,364 chains (27.4km) of 12inch (305mm) Cast Iron water supply main

And all to be done for the princely sum of £116,324 4s 7d ($232,649.46 in 1885 values).

The Victoria Dam near Perth photographed c 1900, not long after it opened. Photo by Rae Bros. of Perth. Note the man and woman on the narrow and unguarded dam wall. The man is carrying a shovel over one shoulder and a brief case in the other hand. This image was used in a story about Perth's First Water Supply in the March 2015 issue of EHA Magazine. Source: Water Corporation.

The Great Typhoid Outbreak

During the early 1890s the discovery of gold in the north and east of WA resulted in a significant increase in the population of Perth – rising from 8,500 in 1818 to 61,000 by 1901. Many of these people were itinerant, staying in Perth long enough to gather supplies before setting off to the Goldfields. Large tent cities were established, generally around the shores of the northern lakes. Reticulated water was limited to only about 2,750 properties in the City, and nightsoil collection only reached about 5,500 properties. Everyone else relied on the shallow wells which were becoming increasingly polluted because of the influx of the gold diggers. It was no surprise then that Typhoid became endemic;

- 1895: 566 cases, 70 deaths;
- 1896: 663 cases, 89 deaths;
- 1897: 1408 cases, 134 deaths;
- 1898: 800 cases, 74 deaths;

The last straw came when water samples from the reticulated scheme water were also found to contain typhoid. More than 500 ratepayers gathered in the Perth Town Hall in November 1896 and demanded that something be done! In response to this the Government of the day undertook several far-reaching engineering initiatives to deal with the Typhoid epidemic.

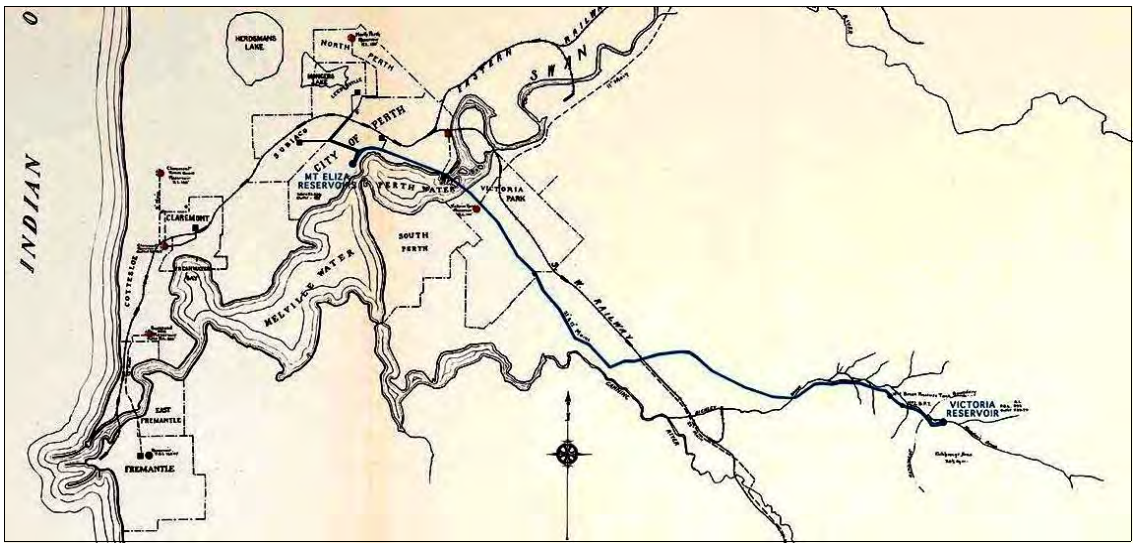


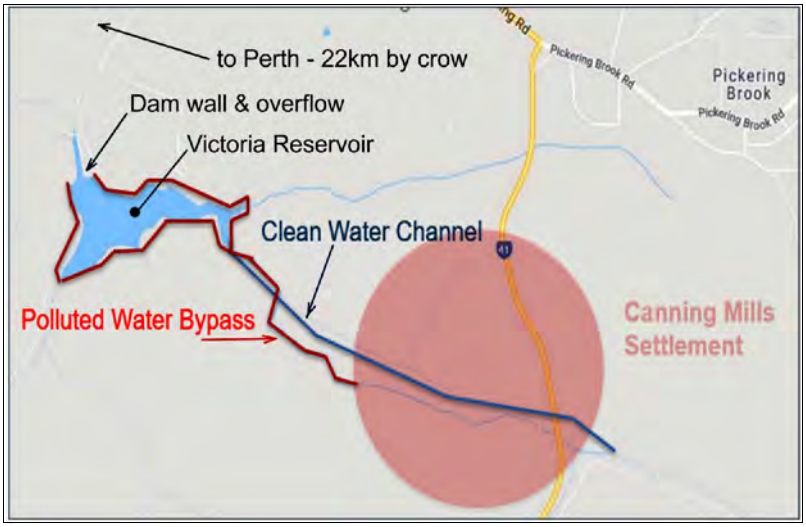
Image at Left:
Part of a 1903 plan of Perth & suburbs water supply.

The dark blue line drawn on the plan shows the route of the 1895 pipeline from Victoria Reservoir (at right) to the Mt Eliza Reservoir (at left) in Kings Park close to the City.

Source: Water Corporation.

Water Supply

- The polluted runoff from the area of timber mills and farms at Canning Mills Settlement, immediately upstream of the City's major water supply dam, Victoria Dam, were bypassed around the reservoir. (There were 3 timber mills, 400 people and up to 200 horses operating and living in the catchment, plus a butcher shop and a slaughter house);
- The major supply main from the Dam to the City was more than doubled in capacity – from 305mm diameter to 510/535mm.
- Reticulated water was extended into a number of inner-city suburbs.



The Polluted Water Bypass Scheme. Clean water from upstream of the settled areas was collected into a channel (or pipeline) and carried past the polluted catchment, to be discharged into the Reservoir. The Polluted Water Bypass picks up the dirty water from the settled catchments and run-offs and diverts it around the edges of the Reservoir to rejoin the stream downstream of the dam wall. Source: Water Corporation.

Sewerage

- the tent cities were abolished and more extensive sanitation bylaws we introduced and enforced.

Drainage

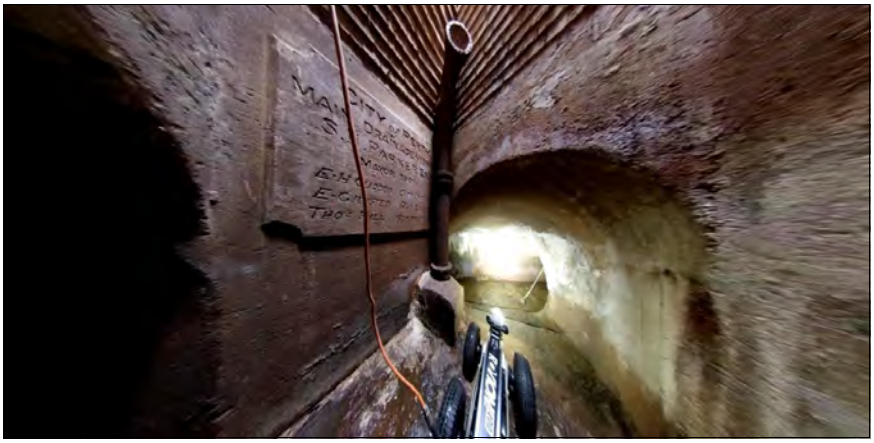
- A new system of main drains was constructed to drain the more shallow northern lakes and prevent flooding of the large lakes, at a cost of over £100,000.

A 1900 photo of Victoria Reservoir. At centre left, two large pipes discharge clean water from the Clean Water Channel (see diagram above) into the Victoria Reservoir. At centre right, the wall is part of of the Polluted Water Bypass (as above) – a diversion dam which captured the polluted run-off from the mills upstream of the Reservoir and diverted it around the edges of the Reservoir. Source: Water Corporation.

Recent Discovery

The drainage works undertaken were some of the largest engineering works ever carried out by the Perth City Council (drainage did not come under central government control until about 1910). They were of mass concrete construction, 4 feet (1.6m) in diameter, discharging into the then open channel Claise Brook (enclosed in an 8 feet 6 inch diameter (2.59m) brick-lined drain in 1905). The Council was so proud of its 1901 achievements that they were commemorated in a small gallery built off the main drain.

This gallery was last sighted in 1983 when a tour of the then Metropolitan Water Authority executive inspected it and walked out to the (then) open end of the Claise Brook main drain. With more stringent Occupational Health and Safety regulations happening not long after, further human access was thereafter banned, and this gallery soon became an urban myth.



The photograph of the Foundation Stone as taken by the ROV last year at the junction of several main drains in East Perth. The Water Corporation prefers not to disclose the exact location of the Foundation Stone - to deter urban underground explorers!

This myth was first told to the author by 'an old lag' in the early 1990s, and despite much discussion with other staff and searching of old plans over the years, the story had never been able to be substantiated. Earlier this year the author had the Water Corporation's ROV (remote operated vehicle) team doing an inspection for him and they mentioned they were going to this drain the next day. He recounted the urban myth and at around 1400 hours the next day, he got an excited phone call – *We've found it !* A charming brick-built access chamber, beautifully corbelled and with a 3m x 2m *Foundation Stone* set into the concrete and clearly reading:

This photo at left, from the Water Corporation website, must have been taken when the ROV camera was alongside the Foundation Stone.

City of Perth
Main Drainage Works
S.H. Parker Esq.
Mayor 1901
E.H. Gliddon City Engineer
E.G Jedsted Res Engineer
Thos Hill Contractor

Of course, word soon spread like wildfire within the Water Corporation, so much so that Channel 7 television ran a feature on it in the night time news where it was dubbed the "Foundation Stone" for the modern city. The follow up story on the Water Corporation's external website still holds the record for the most ever hits!

Unfortunately, while the exact location cannot be divulged, to deter urban explorers, it remains an example of a real engineering solution which has remained in use for over 110 years and, in direct contrast to its predecessors, has never failed in its duty.

Conclusion

It is often a contention amongst Engineers that the provision of safe water and the disposal of wastewater and urban drainage has eliminated more diseases and extended life expectancy more than all the medical discoveries of the last two centuries combined. While this is a gross simplification, there is an element of truth in it – Bazalgette's sewerage of London being the prime example. Good engineering, working hand in hand with sound medical knowledge can make a great difference. This is happening today, as we write, with the treatment of Covid patients in ICUs via microprocessor controlled ventilators (introduced in the 1980s), and improvements in the ventilation of hospitals and quarantine hotels, reducing the spread of Covid. Good engineering did the same over 120 years ago in Perth with Typhoid, drastically reducing the incidence of the disease within a few years of the drainage and water supply improvements.

Repairing Kempsey Railway Bridge
after damage from the record flood of 1950.

By Bill Phippen

The first railway between Sydney and Brisbane, completed in 1888, took a circuitous and steep route, reaching the highest point ever attained by a main line railway in Australia – 4517 feet (1377m), near Ben Lomond on the Northern Tablelands in NSW. The more direct and more useful route closer to the coast was precluded by the many coastal rivers with their wide estuaries which would have to be crossed. In Australia in 1880 neither the economy of the Colony, nor its engineering capacity, could cope with building so many long bridges. By the second decade of the twentieth century however the story had changed, and the decision was made to build a new interstate line, closer to the more densely populated coastline. This became the North Coast Railway, from Maitland near Newcastle along a much flatter route. The highest elevation reached would be at the (Queensland) Border Loop, and that was only 890 feet (270m).

The Kempsey Bridge viewed from the East (downstream) and showing most of the original steel spans over the River (left) and part of a 1960s viaduct over the Flood Plain (right). A long goods train is crossing the bridge and heading for Queensland. No photograph showing the complete crossing with the original timber trestle viaduct, could be found.. Photographer Neil Munro, 31st May 1983. Source: NSWR Photo ARHS 451909.

One of the rivers to be crossed was the Macleay, and the site chosen was in the town of Kempsey situated on both banks ofthe River. James Waller Roberts[1] had designed a series of standard steel bridges which were used as required for the many river and creek crossings on the North Coast Railway.

At Kempsey, the bridge comprised a 66 feet 4 inch (22.22m) through plate-web girder, three 200 feet (61m) through Pratt trusses and a second 66 feet 4 inch plate-web girder. The main channel of the river was near the high south bank so no approach spans were needed there, but a wide flood plain extending north beyond the steel bridge required a long viaduct consisting of a series of 24 feet (7.3m) long "timber openings", with embankments between them.

The first (No.1) viaduct section of five timber spans, came immediately beside the steel bridge, then there was an embankment, then No.2 section of eleven timber spans, a second embankment and then, furthest north, No.3 section of twelve timber spans, before the northern bank was reached.

Kempsey, showing Middleton St, the Macleay River, the Flood Plain & the Railway Station. Source: street-directory.com.au

1 Roberts, James Waller (1871 - 1948) – see: https://www.eoas.info/biogs/P006199b.htm

Repairing Kempsey Railway Bridge

The line opened to Kempsey on 27 November 1917. In one sense the line was completed into South Brisbane in 1930 when the Uniform Gauge line was carried through the Border Ranges into Queensland, but perhaps the true completion should be considered as 1932 when the Clarence River Bridge at Grafton was opened, thus sparing passengers the river crossing by a small passenger ferry and the goods wagons by a journey on the famous *Swallow*[2] train ferry.

For the 30 years after the opening of the Kempsey Bridge, perhaps the weather was dry enough to not challenge the design engineers' calculations of the flood capacity of the Macleay River. But in August 1949 a very large flood caused damage to the bridge – specifically to the No.1 viaduct immediately adjacent to the steel bridge. One trestle pier had to be replaced and others had to be given concrete caps. This was a technique widely used by the New South Wales Railways (NSWR) whereby the life of piled timber trestles was extended. The deeply buried part of a pile does not generally rot, and the upper section in the open air has a long life, but the short length just into the ground deteriorates quickly. By inserting a concrete cap, still supported on the buried parts of the piles, and making the upper timber work a separate and maintainable open-air structure, a sound bridge was reconstituted.

The 1949 repairs to the No.1 viaduct section, as exposed in 1950 and seen from the east (downstream) side of the bridge. Originally the structure would have been simply driven timber piles, but the concrete pile caps were added after flood damage and 35 years of rot at ground level. Source: NSWR Photo ARHS 126879.

The 1950 flood at its peak. No record exists of who was intrepid enough to venture out onto the bridge at this time to take this photo. The view is from the south end of the bridge, looking north. The timber footway at left (upstream) was destroyed. Source: ARHS 122479.

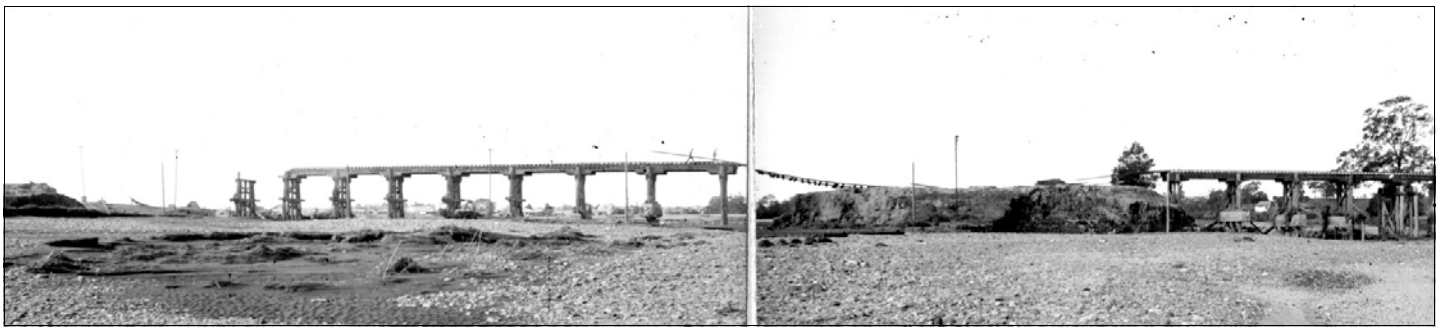
The repaired No.1 viaduct was not in service long before another, even greater, flood descended on the bridge on Saturday 24 June 1950.[3] The peak of the flood occurred in daylight hours and someone was game enough to take photos of the flood waters overtopping the deck of the steel bridge. The pedestrian walkway outside the trusses was all but completely swept away, but the steel work and the concrete piers were undamaged.

The northern approach however had not survived. No.1 viaduct was heavily scoured such that the concrete pile caps were left high in the air. There was so little of the piles still in the earth, that later, when the timber spans were removed as part of the repair, the trestles fell over once that lateral support was taken away. The embankment between No.1 and No.2 viaducts was heavily eroded and No.2 viaduct was damaged beyond repair. There was also damage to the embankment between No.2 and No.3 viaducts and the timber abutment at the southern end of the latter structure was lost. No.3. viaduct was otherwise intact.

The remnants of the pedestrian walkway on the west side of the bridge, immediately after the flood.
Source: NSWR Photo ARHS 126892

2 Train Ferries on the Clarence – see: https://viewmarkfilms.com.au/train-ferries-on-the-clarence/

3 https://trove.nla.gov.au/newspaper/article/234558429?browse=ndp%3Abrowse%2Ftitle%2FM%2Ftitle%2F1220%2F1950%2F06%2F30%2Fpage%2F25357586%2Farticle%2F234558429 From *Macleay Argus*, 30th June 1950.

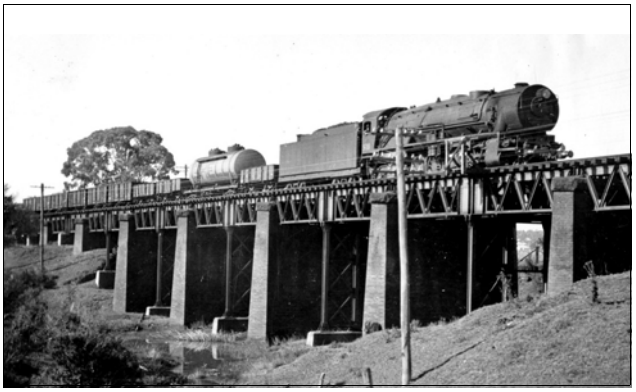


A panoramic view from the west of some surviving sections of the viaduct, as it was immediately after the flood. The steel truss bridge is out of sight to the right (south). No.1 timber trestle section is at right, then a partly washed away embankment, then what remained of the No.2 trestle section on the left (north). NSWR photographers often took 'panoramic' photos as several individual shots later physically compiling the prints with scissors and paste.

Source: NSWR Photo ARHS 126903, 6 July 1950.

Patching up the old timber No.1 and No.2 sections of the viaduct was not considered possible, so a new viaduct would have to be built, and quickly. The NSWR had a long-standing policy of dismantling and re-using superseded bridges. What was no longer up to the standard required for a busy main line would be quite acceptable on a lightly-loaded branch line with lower speeds and smaller engines.

Old bridges were certainly stored at Clyde in Sydney as there are surviving plans and inventories of the stock. The 'new' bridge at Kempsey would be of 13 x 44 feet (13.4m) spans, completely replacing the two destroyed timber bridges and the embankment between them. The spans would be Warren deck-trusses recently removed from the Main Western Line between Parramatta and Penrith. Around 1884, wrought iron Warren trusses had been used at fourteen locations to replace the original 1860s timber bridges on that section. Around 1920 the trusses were strengthened by the provision of an extra steel trestle pier at the middle of the span. This concentrated load required the shear capacity of the girder to be increased locally so the centre panels of the Warren truss were provided with plate webs. Although at least thirteen of these spans were out of use and available for Kempsey in 1950, one of the fourteen Main Western Line bridges, at Werrington, remained in service until 1992.



This bridge at Werrington on the Main Western Line is built with the same type of 1880s wrought iron Warren trusses as were re-used at Kempsey in 1950. These had been strengthened in 1920 with added mid-span trestle piers and web plates. This Werrington bridge structure remained in service until 1992.

Source: NSWR photo ARHS 008294, M.Sharland.

The truss spans to be re-used were available, in Sydney, and their transport was not a problem once a separate flood at Maitland near Newcastle subsided to allow the Main North Railway to re-open. They weighed only 7¼ tons each and fitted, complete, within the loading gauge of the railway. There was an issue however in that the new bridge viaduct would have to be built starting from the north side of the Macleay Flood Plain, and working south towards the undamaged steel spans over the main river channel. The train carrying the materials for the new bridge could not reach the north side of the river across the wrecked bridge.

To maintain a passenger service, as soon as the worst of the flood had passed, trains used a temporary halt at Middleton Street level crossing, a short distance south of the impassable bridge. Passengers were loaded into buses and carried via a road bridge to Kempsey Railway Station, north of the river, and another train for the completion of their journey. The thirteen Warren trusses would have to go the same way, on a road jinker.

Image Left: A road jinker carrying one of the Warren truss spans through the main street of Kempsey, from Middleton Rd level crossing across the river to the Railway Station. Source: NSWR photo ARHS 126891.

Transferring a Warren truss span from rail to road at Middleton Street level crossing. Note the arrangement of the crane with caterpillar tractor, the beam to the rubber-tyred axle and the shear leg tied back to the tractor. Source: NSWR Photo ARHS 126889.

First, the Warren trusses had to be unloaded from the train which had brought them from Sydney. Any study of 'heritage' engineering and the work methods used in the past highlights the one piece of equipment which was missing – a sophisticated and powerful crane.

The device used at Kempsey to unload the spans at Middleton Street and then to re-erect them in the middle of the Flood Plain seems to be a hair-raising contraption to a modern eye. Power and mobility were provided by a caterpillar tractor, from the back of which a long beam or strut extended to a set of rubber-tyred wheels. From their axle a long boom extended, very much as a set of shear-legs, stayed by cables back to the tractor, which was not only heavy, but quite a distance away. Since the flood plain was a sea of mud for the duration of the project perhaps the caterpillar tractor was the only machine which could have coped.

Unloading the jinker using the goods yard gantry crane at Kempsey railway station. Source: NSWR Photo ARHS 126888.

Once the load was taken by the crane the jinker was moved away and the span lowered onto railway wheels or track rollers.
Source: NSWR Photo ARHS 126890.

So, each of the Warren Truss spans was loaded onto a road jinker at Middleton St and driven across the road bridge over the Macleay River, through the main street of the town and to the railway goods yard. Here there was a gantry crane normally used to unload heavy items from rail wagons and it could lift the trusses from the jinker, lowering them onto 'track rollers', specially made on site. It was still half a mile to the place of use, but human muscle was enough to move the seven-plus tons.

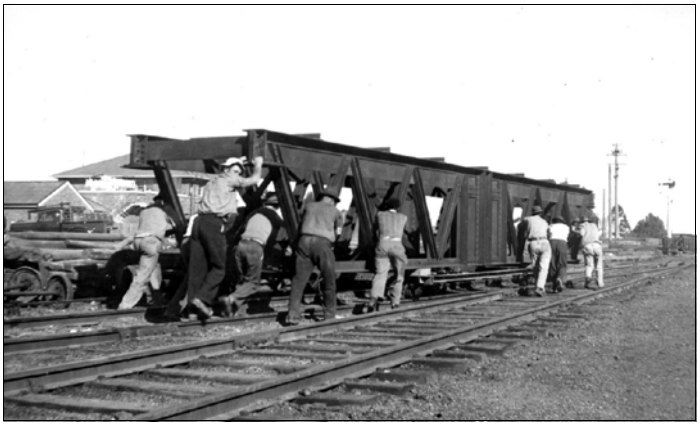


Image Right: Muscle power was used to propel the seven-plus ton assembly for half a mile to its place of use. Source: NSWR Photo ARHS 126884.

Repairing Kempsey Railway Bridge

There was a lot of preliminary work to be done, demolishing the wrecked No.1 and No.2 viaduct sections, removing the no longer needed embankment, making some sort of foundations for the new piers and then erecting the piers themselves. The thirteen spans were stockpiled in a queue on the No.3 viaduct section, just behind its southern abutment which had to be repaired. Here transoms (or sleepers) were fitted to carry the rails.

While the No.3 viaduct section was largely undamaged, its Sydney-end abutment was destroyed. Here a dragline makes repairs, while to the left, wrought iron Warren trusses are ready to move to the repair site. Source: NSWR Photo ARHS 126887.

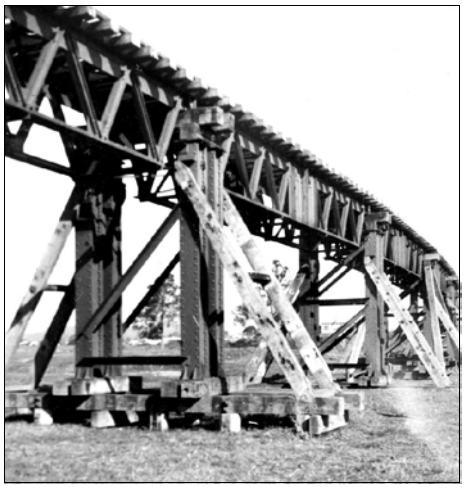


Image Upper Right: The thirteen truss spans were parked on the undamaged No.3 viaduct until the new piers were ready to receive them. Source: NSWR Photo ARHS 126886.

Image Left:: The vertical steel columns as the main load carrying component of the piers probably came from the Main Western Line. The structure is a composite one made from whatever materials could be quickly found. Strong diagonal struts are provided to resist future floods. Source: NSWR Photo ARHS 106175

The new piers were a mix of timber and steel. The probable, but undocumented, source of the braced steel columns is the 1920 trestle piers from the same sites as the Warren trusses. They do look very similar. The new structures were heavily stayed against future floods with timber props and the whole structure seems to have rested on timber bearers, presumably supported by a wide grid of driven timber piles.

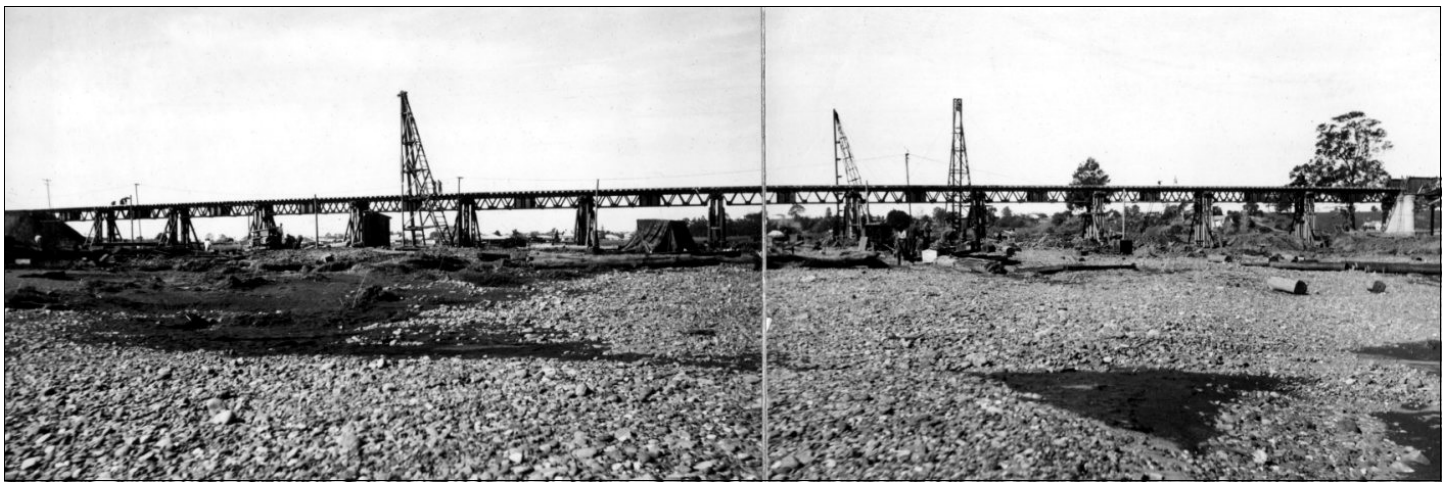
With the piers complete, the caterpillar tractor contraption was brought onto the flood plain and used to erect a falsework span across each opening. Onto this each span was pushed, lifted by the crane, and with the falsework moved aside, lowered into its final position.

Image above: A wrought iron Warren truss has been rolled forward on falsework and lifted by the caterpillar crane. The NSWR caption for this photo draws attention to the mud which persisted for the duration of the job. Source: NSWR Photo ARHS 126880.

Image Right: With the falsework moved aside the span is lowered into position. It already has transoms fitted and rails will soon be dragged forward for the next span to be rolled ahead. Source: NSWR Photo ARHS 126876.

Repairing Kempsey Railway Bridge

The line was cut on 24 June 1950 and re-opened on 20 August when the Sydney-bound Brisbane Express passed through Kempsey at 9pm. (Macleay Argus). The elapsed time for the repairs was just 57 days.



The completed 'temporary' viaduct. It remained in use for 16 years. The view is from the west - the same as the panoramic view of the wrecked viaduct on the third page of this story. The end of the plate web girder at the south end of the viaduct can just be seen on the right. Source: NSWR Photo ARHS 126899.

The repairs described in this article were of course only of an emergency nature to allow the resumption of traffic as soon as possible. Speed across the 'new' bridge was limited to 4mph (6km/h) pending proper repairs - which took 16 years to be completed!

One proposal which is of particular interest to this author was the re-use of parts of the dismantled 1889-1946 Hawkesbury River Railway Bridge to bypass not only the re-cycled Warren truss and timber trestle viaducts across the Flood Plain, but also the 1917 three x 200 feet (61m) Pratt trusses and the two plate-web girders across the river, all in only six spans.

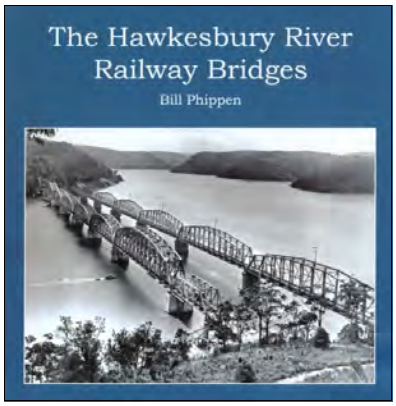
Perhaps by 1966 civil engineering had made a quantum leap in sophistication. To increase flood clearance the steel trusses were raised 4 feet (1.2m), under traffic, and a new northern approach was constructed on a convergent alignment with the girders adjacent to the Pratt truss spans slid into place during a brief traffic close-down. But that would be a story for another day.

Bill Phippen

From the Editor :

In the May 2020 issue of this magazine, Bill Phippen wrote about *Making Photo Archives Accessible*. This referred mainly to the NSW Railway collections held by the NSW State Archives & Records Authority (SARA). He says: *One of the most used series in the collection is NRS17420, State Rail Authority Reference Photo Collection. It comprises 52 large file boxes of photos pasted on large cards*. The number of images on the cards was found to be 32,409! The Australian Railway Historical Society NSW Division, through its archives wing, the Railway Resource Centre (RRC) offered to scan the whole collection. A team, led by Bill, was set up to do the scanning, which is done at a very high standard. He said: *A typical day produces about 80 scanned photos*. The work started in May 2019, but was abruptly halted (like so much else) at the onset of Covid 19.

How they are going now I don't know, but they got an amazing amount done before Covid struck. Bill made the point to me that the digitising of these cards is allowing a number of great stories from the history of the NSW Railways to come to light. His stories of the St Helena Washaway (May 2020 EHA Magazine), and this Kempsey story, would not have been possible without the photos the team found and the information on the photo cards enabling further research into the paper archives.



One other thing – about the 1966 re-repairs of the Kempsey viaduct and bridge – Bill observed, in his second last paragraph above: *One proposal which is of particular interest to this author was the re-use of parts of the dismantled 1889-1946 Hawkesbury River Railway Bridge*. And the reason for his interest? Readers may remember that Bill Phippen is the author of the Colin Crisp Awarded book *The Hawkesbury River Railway Bridges*, which I reviewed in the September 2018 issue of this magazine. I understand that this excellent book is still for sale.

Dr Ray Boyle of Rockhampton

Is he EA's longest serving member and oldest member?

From the Editor.

Since I started the EHA Magazine in 2013, I have made a number of interesting friends in my searches for contributions to be edited into magazine stories. When I say friends – more like pen pals really – I live far from anywhere that really matters, away in the bush, and it's unlikely I could ever actually meet most of my new friends in person. Dr Ray Boyle, DipMEE, ADME, MA, PhD, FIEAust, CPEng, with his formidable list of post-nominals, is one of those new friends. But he is different – we soon discovered we had an affinity, and our formal correspondence became more an exchange of life experiences and current preoccupations and happenings than work and business.

Our first exchange, in 2017, was something to do with a book that a friend of his had written, but I very quickly discovered that Ray was considered to be the go to expert on anything to do with the famous gold mine at Mount Morgan, near Rockhampton in Central Queensland. Of course I asked him if he would prepare a story about the history of the mine, for the Magazine. That story was published in EHA Magazine in January 2018 - see: https://www.engineersaustralia.org.au/sites/default/files/resource-files/2018-02/EHA_%20Magazine_Vol2_No7_January_2018.pdf

Dr Ray Boyle, DipMEE, ADME, MA, PhD, FIEAust. on his PhD graduation day in 2014. Photo: CQU.

Ray was born in 1930, which makes him 91 years old in this year of 2021, and he is still going very strong. I found him quite amazing in his youthful energy and it is astonishing how much he has packed into that 91 years – particularly into the last 20+ years since he reached most people's retirement age. I wish I had done half as much in my old age.

Part of that time has been taken up with family histories – research and writing six books, from one about an Archdeacon great great grandfather who settled in WA in 1841, to a grandfather with a pastoral property near the village of St Lawrence, about 100 miles north of Rockhampton. He has fond memories of his early life at the St Lawrence property – living there until he was 6½, and holidaying there until he was 19. That was when his life was getting serious.

At 17 Ray started work as a Fitting & Turning Apprentice with Mount Morgan Limited, and enrolled in the Diploma of Mechanical & Electrical Engineering (DipMEE) via Queensland University through Night School at Rockhampton Tech. Two years later, on 16th October 1950, he joined Engineers Australia as a student member. After graduation he embarked on an Associate Diploma in Mechanical Engineering, completing an arduous night school education in 1969. At the Mount Morgan gold mine, from 1948, he rose steadily through the ranks to the top, as Chief Engineer, Mount Morgan Limited from 1970 to 1983. His list of "past" community and charitable interests takes up a full page of his CV.

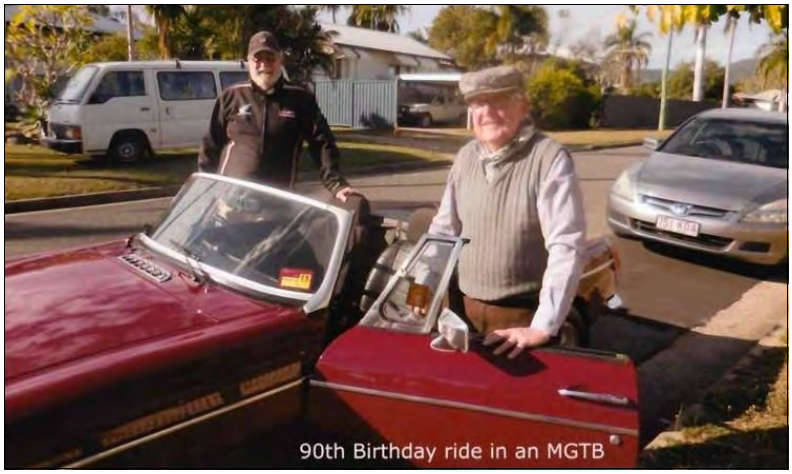
Ray also rose steadily through the levels of Engineers Australia and the Australasian Institute of Mining & Metallurgy, to Fellow of both from 1992. But it is the huge number of other things he has been engaged with, particularly since 1983, that I find quite astonishing. He has been a Registered Professional Engineer in Queensland and a Consulting Engineer in private practice, an Engineering Heritage Consultant, a university Admin. Officer and a Lecturer (in Mechanical Engineering). He has done at least 15 different heritage projects and studies, and written and delivered more than 30 conference papers and published articles. You can find all these, and many more things he has done, in his Partial (as he calls it!) CV at:

https://www.engineersaustralia.org.au/News/interview-dr-ray-boyle-fieaust-cpengret

Dr Ray Boyle of Rockhampton

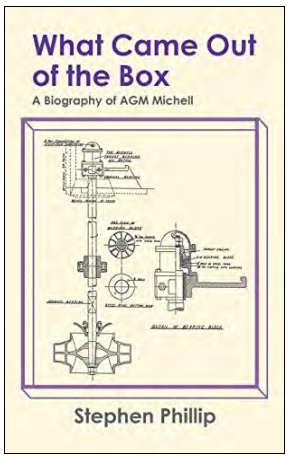
Even more astonishing are his more recent academic achievements. In 1995 he was awarded a Master of Arts from Central Queensland University (CQU). His subject was *A Study of the Management and Growth Patterns of Mount Morgan Limited, 1929-1950*. And in 2014, at the age of 84, he was awarded a PhD from CQU. His doctoral thesis is titled *Mount Morgan Limited, The Disappointments and Triumphs, 1932-1990*. It is available for download at:
https://acquire.cqu.edu.au/articles/thesis/Mount_Morgan_Limited_The_triumphs_and_disappointments_1932_-_1990/13438298

How Ray has managed to do all these things (and how many more?), and help his beloved wife Greta bring up their four girls is difficult to understand. Those girls have all grown up and given him a number of grandchildren and great grandchildren. I haven't caught up with all those numbers. In the photo at right, Ray (at right) is about to be taken for a ride in an MGTB to celebrate his 90th birthday. I wonder if he revisited Mount Morgan?


90th Birthday ride in an MGTB

There is so much more I would add if I could, but I would like to say how much I enjoy Ray's emails and phone conversations, and I have fun telling him about my own life and adventures.

Connections



Some of you may remember Stephen Phillip's story about the life of AGM Michell which was published in the EHA Magazine a year ago – in the September 2020 issue. At the time, Stephen had completed a full biography of Michell, and it was awaiting publication. *What Came Out of the Box* was released in October 2020, but I didn't find out for some time, so I apologise to Stephen for this very late notice. The book is for sale through Dymocks, Amazon and some English booksellers.

The spiel tells us: *Anthony George Maldon (AGM) Michell was undoubtedly one of the greatest Australian engineers. A prolific inventor, he is best known for his tilting pad thrust bearing. It remains one of the greatest inventions in lubrication science, and revolutionised ship propulsion - without it, modern shipping would not be possible.* And about the author: *Stephen Phillip is a mechanical engineer and lives in Melbourne, Australia. His fascination with Michell began while he was a student at Melbourne University. He was surprised to discover that a comprehensive biography of Michell did not exist, so decided to write one himself.*

Back in May 2021, Stephen Phillip gave a talk about AGM Michell to the Newcomen Society in the UK. The Society has since put the talk on YouTube, and here it is: https://www.youtube.com/watch?v=pqUjIZUCXC0

The ICE Archive

A while ago Newcomen Society (UK) notified of a coming webinar about Brunel in South Wales. It was the second of a series to be held by the ICE, in conjunction with the Newcomen Society. Recordings of these two webinars have been uploaded to the website of the ICE's Archive, and Panel for Historical Engineering Works - see: https://www.ice.org.uk/knowledge-and-resources/historical-engineering-works/results?q=Brunel&searchType=1 (or Google ICE PHEW). No doubt the next two webinars will be recorded and will also be uploaded to the ICE Archive.

The most notable thing about this search was to remind me that *the ICE archives are open to ICE members, researchers and any member of the public.* But how much of their enormous and fascinating collections have been digitised is a question – and how many digitised documents are accessible to overseas researchers who are not members? Some are free and available through public or institutional library access, but you have to be a library member. However a search on https://www.icevirtuallibrary.com/ is worth a try.

Connections

National Communication Museum

Reading Tony Wright's latest great story in Saturday's Age (16th September), he reminded me of Evelyn Waugh's hilarious book *Scoop* from long ago. And I understand how much it would appeal to a travelling newspaper correspondent. I was never one of those, but I remember how fraught it could be trying to communicate with employers, clients, and family when living on the other side of the world from them. The story can be read at:

https://www.theage.com.au/culture/art-and-design/in-memory-of-cleft-sticks-and-the-frustrations-of-sending-a-story-20210916-p58s7h.html

But that wasn't the purpose of this entry in Connections. That was to be about the history of communications connections. In passing, Tony mentions a *National Communications Museum* being built in the old telephone exchange in Burwood Road, Hawthorn in Melbourne. He says: *For more than 60 years, a small band of enthusiasts who have worked for the Postmaster-General's Department (PMG), Australia Post, Telecom and Telstra have been collecting and preserving communications artefacts: telegraph and telephone equipment, postal bags, uniforms and machinery, cables and equipment, photographs and ephemera dating back to the 1850s.* The website of the NCM is at: https://www.ncmuseum.org.au/ Follow that up to find out more. I know my partner Carl will be interested – he spent a couple of years working in the PMG Research Laboratories in Melbourne in the '60s. So much of what was new then is history now!!

Heritage Newsletter

You can now sign up to receive the Heritage Council of Victoria's quarterly Heritage Newsletter which will keep you up-to-date with current news, upcoming events, recent registrations on the Victorian Heritage Register, and stories from custodians and community members about that state's cultural places and objects. This started in May – no doubt a response to Covid – so only two issues so far. Find it at:

https://heritagecouncil.vic.gov.au/get-involved/heritage-newsletter/

ASME'S Historic Mechanical Engineering Landmarks

As a contrast to the UK's ICE Archive on the previous page, here we have the American Society of Mechanical Engineers Landmark program's web pages at: https://www.asme.org/about-asme/engineering-history/landmarks An eclectic collection of 276 Mechanical Engineering Landmarks, sorted by date of "landmarking", starting in 1973 with No.1, an 1887 Cable Railway Powerhouse in San Francisco (where else?), and finishing so far, in 2021, at No.276, a virtual landmark of Carnot's 1824 book on heat engines.

The Landmarks can be searched by topic – in an idiosyncratic listing which places an earthmover/scraper under Agricultural, and a cog railway under Music – and by location, with the vast majority (of course) being in the US. Other countries have one, two, or perhaps three entries. Australia scores one Landmark, No.111 – the 1875 Boulton & Watt Rotative Steam Engine in the Powerhouse Museum in Sydney. Compared to many of the Landmarks, the Boulton and Watt scores a comprehensive and interesting "Brochure", but has a faulty link to the Powerhouse Museum's website.

NSW Heritage Library - Catalogue and Digitised Material Online

Some welcome news from Ken McInnes in Victoria. He was the first to tell us that Heritage NSW, in Sydney, has been busy digitising some of the contents of its Library, He says: *I have recently come across the Heritage NSW, Digital Heritage Library. This contains about 10,500 useful reports, books and guides, covering not only NSW, but other states, many National reports, as well as many useful overseas reports and guides.* Find the catalogue at:

https://heritagensw.intersearch.com.au/heritagenswjspui/simple-search

The catalogue yields an amazing range of digitised reports, but I would like to know how much has not as yet been digitised. Searching under Doring, I could find only some of our reports that were given to the Library as a contractual requirement.