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Cover Images:

Front: A recent aerial photo of Cockatoo Island.
Source: Sydney Harbour Federation Trust.
Photo: Ashley Mackevicius, 2008.

Back: The Flagship of the RAN, HMAS "Australia" in the Sutherland Dock at Cockatoo Island, Sydney, in May 1914.
Source: J Jeremy collection.
The original negative is in the State Library of NSW, Mitchell Library collection.

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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We ran out of space in Connections, so here is a story about Midget Submarines.

I wonder how many remember the time in 1942 when the Japanese invaded Sydney Harbour with three midget submarines? I don't remember it – I lived far away in Melbourne then, but my partner Carl does. He was 4½ at the time, living in Coogee, and his Mum and Dad woke him up that night to watch the flashes and hear the sounds of explosions up to the north in Sydney Harbour. Carl has also told me how his Dad, who had a business melting and refining scrap lead, was offered the midget sub's batteries. He turned down the offer. He thought they looked a more advanced design than the batteries we had, and should be examined by Australian Government scientists. I wonder what did happen to those batteries?

Maritime Archaeologist Tim Smith, doesn't remember that day, but he knows an awful lot about it. A while ago he sent us a link to his conversation about it with Richard Fidler on the ABC on 9 Nov. 2020. Well worth a listen, but you may need to copy the URL into your search engine or go to ABC Conversations for 9 Nov 2020:

<https://www.abc.net.au/radio/programs/conversations/midget-subs-attack-sydney-ww2/12841278>

Editorial

I was very pleased to receive the comprehensive and fascinating story about the industrial history of Cockatoo Island from John Jeremy, the CEO of the last industrial operation active in the dockyard until mid-1991. I never visited the Island myself, neither in its “Industrial Powerhouse” times, nor in its time of idleness in the years since 1991, but I was conscious of the Island’s presence in the Harbour, and particularly of its famous giant floating crane Titan that was moored at the Island, and worked there and up and down the Harbour for 70+ years. I found Titan fascinating, and well worth a magazine story to itself, together with a version of a Catalogue Raisonné of all her notable lifts down the years. She gets an honourable mention in John Muirhead’s story of the building of the Gladesville Bridge in the 1960s (EHA Magazine, September 2019), but there are so many other notable jobs Titan engaged in. What I find hard to come to grips with is the shameful way she was sold off, by the Government, for a derisory sum, and abandoned to the high seas and inevitable death instead of being protected by the Heritage Act and preserved at her historic mooring for future generations to wonder at. Her sad end is a disgrace. It’s what I call one of my Heritage Horrors. If you want to know more, google “Australian floating crane Titan”, and find a wealth of information. And I hope one of you will write Titan’s story for me. I just don’t have the heart.

And before the disastrous bushfires of late 2019 to January 2020 fade from your minds, we have a story from my Gippsland friend and heritage conservation colleague Helen Martin, of the loss of some of Gippsland’s precious engineering heritage, in the form of some of the last extant timber truss bridges in Victoria. Another sad story, but one not widely known. I wonder how many more items of our industrial/engineering heritage were lost in other parts of Australia in those bushfires. There must have been many historic shearing sheds and dairies and businesses like butter factories and timber mills and engineering workshops lost, not to mention more bridges, in other states than Victoria. The media concentrate heavily on dwellings, but it would be good to have an accounting. Perhaps some of our readers will be able to tell us more?

The Editor

In honour of Jack Munday AO, 1929 – 2020

From the Editor.



Jack Munday. Photo Tony Walters in the SMH.

Stuart Read in the NSW Heritage Network on 11th March, drew our attention to the State Funeral of Jack Munday in Sydney that happened on Wednesday 10th March 2021, not far short of a year after Munday died on 10th May 2020. So many things Covid 19 has delayed - or put off forever! I missed recording his death at the time – I think the media down here was more preoccupied with local affairs back then. Jack Munday’s influence in saving our heritage was always greatest in NSW – specifically Sydney – but his fame spread nationwide, and across the world. I wonder if there are many, particularly among heritage conservationists in this country, who are not aware of his work in starting the Union Green Bans which were so effective in preventing the demolition of so many important historic structures and natural green places, starting with the first Green Ban on Kelly’s Bush in Hunters Hill in 1971. All of us working in the field owe him a vast debt for the way he has changed the thinking of some Australians and some Government organisations, from National down to Local, on the worth of heritage conservation.

I would never have ventured to write an obituary for Jack, but Stuart Read inspired me to search the internet, and here are some of the contributions. In 2020, *Architectureau*, the Newsletter of the AIA told us about him at: <https://architectureau.com/articles/green-bans-hero-jack-munday-dies/>. The SMH had features on him from Mary Ward in 2020 at:

<https://www.smh.com.au/national/union-leader-jack-munday-dies-aged-90-20200511-p54rpf.html>, from Tim Barlass at: <https://www.smh.com.au/national/nsw/sydney-remains-in-his-debt-city-mourns-loss-of-visionary-jack-munday-20210310-p579gd.html> and <https://www.smh.com.au/national/nsw/guardian-of-sydney-s-heritage-was-a-man-ahead-of-his-time-20210310-p579j4.html> from the SMH Editor on the day of the State Funeral. The State Memorial for Jack Munday was recorded on the NSW Government website: <https://www.nsw.gov.au/state-funerals/state-memorial-for-jack-munday-ao>

Recognising Wartime Service in Public Utilities

By Perry Beor

The recent story in the EHA Magazine about the NSW Railway & Tramway WWI Honour Boards reflected a similar experience some years ago with the West Australian Water Corporation's WWI Honour Board in Perth.

From 1912, all Government water supply, sewerage, irrigation and drainage operations in Western Australia were the responsibility of the Metropolitan Water Supply, Sewerage and Drainage Department. By the time war was declared in August 1914, the Department had a workforce of 1,286. Of this group, 351 people joined the Australian Imperial Force (AIF). This sense of duty was reflected in the 1914-15 Annual Report: *The Empire's call to arms has met with a response from this Department that indicates the presence of a strongly loyal and patriotic spirit.*



The "Old Barracks", the home of the WA Water Corporation when its WWI Honour Board was first installed.

Image: Undated, from the Heritage Perth website.

Even by the time of that report, two staff had already been reported killed in action. In each succeeding annual report, the names of those staff members who had been killed in action were faithfully recorded as the first item, totalling 23 people by war's end. Overall, the Department's war record matched those of many other government enterprises, with two Military Crosses, two Distinguished Conduct Medals and a Distinguished Service Order being awarded to its employees.

The efforts of those who remained was also recognised: *The absence at war of a large number of officers has caused considerable dislocation and thrown much extra work on the remaining officers. These have accepted the added burden in a loyal and cheerful spirit, and very great credit is due to the whole staff for most excellent work in dealing under these difficult circumstances with the operations of the Department.* In common with most other government departments, a large Honour Board was unveiled soon after the war. This recorded not only the names of the Fallen but also listed all who answered the bugle's call and joined up from the Department.

For many years this Honour Board resided in pride of place in the old barracks where the Department was based until 1966 when it moved with the rest of the Department to Dumas House. The latter was built as part of a plan to centralise all WA Government departments near Parliament House. Dumas House fulfils this task to this day (though the other four buildings planned in the same area were never proceeded with).



The WWI Honour Board, as restored, and in its new home in the foyer at the Water Corporation HQ. Image: WA Corporation.

With the move of the by-then Water Authority into the purpose-built John Tonkin Water Centre in the early 1980s, the honour board was forgotten and placed in a storage shed at a metropolitan reservoir. It was 'rediscovered' there in 1990, when it was restored and placed back in the foyer at Water Corporation HQ.

The EHA Magazine story (Jan. 2021) of the NSW Honour Boards was complemented by a couple of brief biographies of NSW railway & tramway soldiers – picked from the hundreds of biographies completed for the NSW project. Perry has chosen one distinguished soldier from the WA Water Corporation Honour Board to feature in this story. The Editor.

Recognising Wartime Service in Public Utilities

A Distinguished WW1 Serviceman & Member of Departmental Staff

What was significant in the service of the Department's staff was how many of them replicated their civilian life in the military – supplying water to their customers – though, in this case, it was the front line. The most noteworthy was the Department's Principal Engineer –

Major Frederick Washington Lawson DSO, MICE, MIMechE, MIEAust (1869-1924).

In 1916, Frederick Lawson answered the bugle's call and joined the AIF. He was commissioned into the 6th Tunnelling Company, Royal Australian Engineers, and embarked at Fremantle on His Majesty's Australian Transport *Warilda* for the Western Front, on 1 July 1916 with a number of other employees of the Department.

On 20 September 1917, Major Lawson was recommended for two Distinguished Service Orders (the second being downgraded to a Mentioned in Dispatches as it was related to the first) for basically doing his civilian job in uniform – and under fire. The citations make very interesting reading. (A DSO rates just below a VC and is for distinguished services during active operations against the enemy). His Citations read:

Distinguished Service Order

Major Lawson has been in charge of the Corps water supplies during the period that 1st ANZAC Corps have held the present front, on our taking over this area no water supply existed east of Zillebeke, owing to the impossibility of keeping the water main in operations due to the heavy artillery fire. Major Lawson however did the impossible and by 20th September (1st Battle of the Menin Rd) he had carried his water mains to Bellewaerde Lake and supplied the Advance troops. Major Lawson personally superintended the repairs during the 1st, 2nd and 3rd battles and has continually advanced his mains. He has set an example of devotion to duty and fearlessness which has kept his detachments at work under the severest conditions.



Major Lawson during WW1. Image: Source not provided.

Mentioned in Dispatches

During the 20th September 1917, from early morning till night Major F.W. Lawson with a section of the 133rd Company R.E. (Royal Engineers) under Captain Rhodes worked unremittingly in repairing the pipeline he had previously laid to the front.

The line was again and again cut by shell fire but owing to the personal example of Major Lawson the repairs were quickly effected and the water supply for the front line troops was kept going. He was under continual and heavy shell fire and displayed a fine example of indifference to danger and determination to carry out his work regardless of self.

This Officer was struck by a shell splinter but fortunately was not seriously hurt.

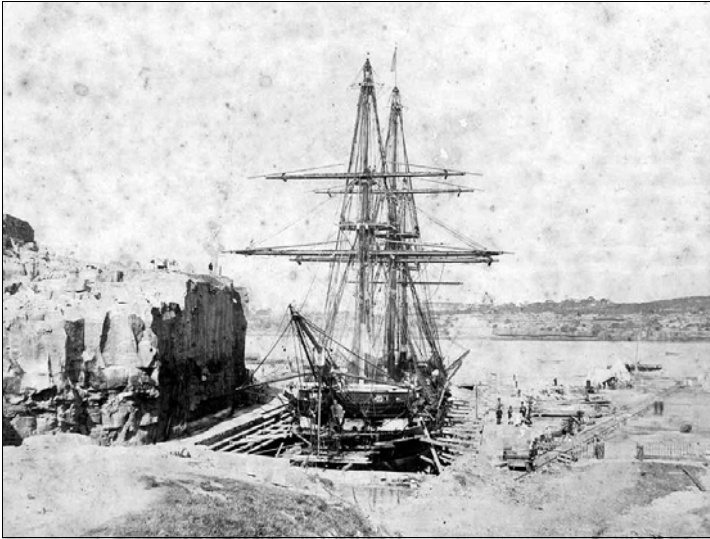
By March 1918, Lawson was the Corps Water Supply Officer, responsible for supplying drinking and washing water for the 110,000 men and 80,000 horses (which required ten times the daily water supply provided to a soldier) of the Australian Corps. He had complete control of the construction and maintenance of pipelines, pumping plant, purifying works and reservoirs for the Corps with as many as 1,200 troops employed on these tasks at any one time. The task was further complicated by the troops having to change their positions almost daily. During the 1918 Autumn Offensive from Villers-Bretonneux to the Hindenburg Line, for example, the Australian troops advanced 50km in three months. The water supply works that were implemented were so effective that during Lawson's tenure, there were no cases of serious disease in the Australian Corps that could be attributed to the water supply.

On demobilisation in June 1919, Lawson returned to his job. Over the next five years, he doubled the available daily water supply in line with the increasing spread of reticulated scheme water in Perth, as well as initiating a number of other far-reaching schemes.

As a sad postscript to this story, however, he committed suicide in November 1924. This followed the collapse of a wall at a metropolitan reservoir – ironically the same one as where the honour board was stored – which had only opened the week before. The subsequent inquiry and a particularly vehement campaign against him by the Daily News, no doubt contributed to what we now know as post-traumatic stress disorder.

Cockatoo Island – Industrial Powerhouse

By John Jeremy



HMS "Curacoa" in the Fitzroy Dock in c1865. Source: State Library of NSW.

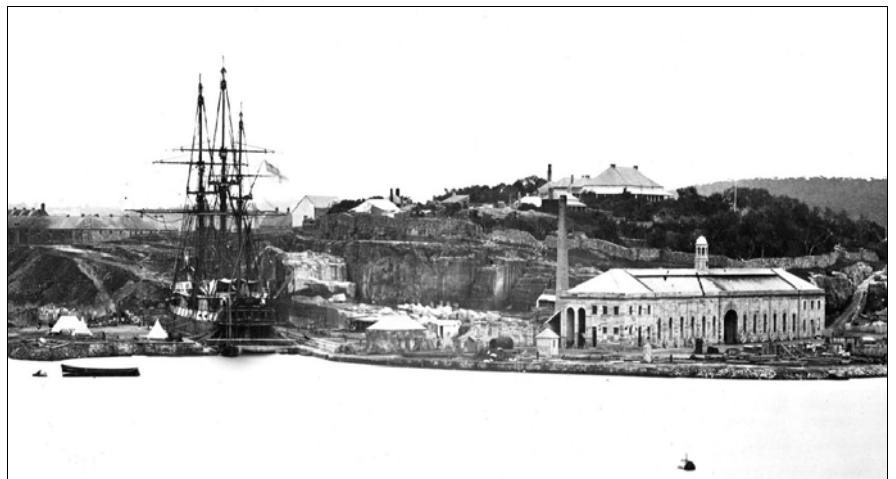
To many people in Sydney, Cockatoo Island in Sydney Harbour is something of a mystery. The largest island in Sydney Harbour, about five km west of the Sydney Harbour Bridge, it appeared to many simply as a large cluster of grey buildings surrounded by ships. It was however, a very busy shipyard, dockyard and engineering works which, over 134 years, played a major role in the development of the Royal Australian Navy (RAN) and engineering projects throughout much of Australia.

European use of Cockatoo Island began in 1839 when sixty prisoners from Norfolk Island were taken there, chained together and under military escort, to begin the island's role as a convict prison. They were set to work building their own accommodation and quarrying stone for works around Sydney like the sea

wall and wharf in Sydney Cove. By 1842, 323 men were imprisoned on Cockatoo Island and the island was to remain a penal settlement in various forms until Long Bay Gaol was opened in 1908. The convict era on Cockatoo Island is a story in itself, leaving a legacy which well justified the inclusion in July 2010 of the surviving convict works on the island on the UNESCO World Heritage List with ten other Australian convict sites¹.

The World Heritage listing not only includes the remaining convict accommodation, but the first engineering works constructed on the island. In the 1840s, there was a need for docking facilities for ships of the Royal Navy stationed in New South Wales and, on 31 October 1845, the NSW Legislative Council proposed the construction of a dry dock on Cockatoo Island for the purpose. Despite a setback when the Admiralty initially declined to make a contribution to the cost, construction of the dock by the resident convicts began in late 1847. The convicts could hardly be described as the most productive workforce and construction of the dock took some time. Named after the former Governor, Sir Charles Fitz Roy, the dock was finally completed for its first official docking, of the survey frigate HMS *Herald*, on 1 December 1857.

A large engineering workshop was also constructed by convict labour near the dock using sandstone quarried on the island. It was completed about 1860 and continued in use until the island dockyard was closed in 1992. The convicts also provided the early dock workers, bringing ships into the dock, operating the dock pumps and shoring the ships as the water was stripped from the dock. Labour for the repair of docked ships was usually provided by commercial contractors like John Cuthbert, who ran the largest shipbuilding and ship repairing business in the Colony, particularly in the 1850s and 1860s.



HMS "Galatea" in the Fitzroy Dock in October 1870, with the convict-built engineering workshop on the right. The workshop building, the dock, and other convict built structures on the island are now on the UNESCO World Heritage List. Source: J Jeremy collection. The negative is in the NSW Government Printing Office collection at the SL of NSW.

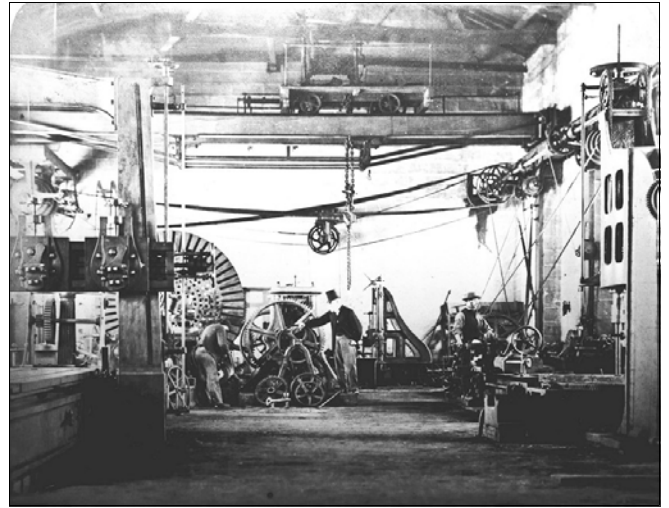
The convict establishment on Cockatoo Island was overcrowded and condemned in 1861, although it was not until 1869 that the prisoners were transferred to Darlinghurst. An industrial school for girls, known as Biloela, was established on the island in 1871. It was closed in 1888 and the facility became the Biloela Gaol as a prison for petty offenders, vagrants and prostitutes. The gaol was finally closed in 1908.

¹ See <https://www.cockatooisland.gov.au/en/> and <https://www.environment.gov.au/heritage/places/national/cockatoo-island> and <https://whc.unesco.org/en/documents/105346>

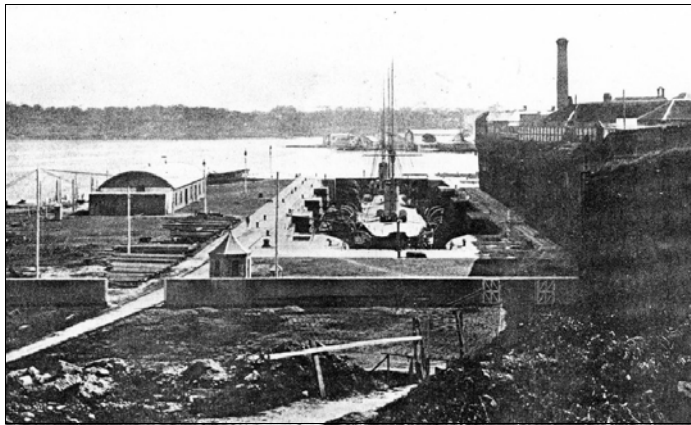
Cockatoo Island – Industrial Powerhouse

Meanwhile, it was not long before the Fitzroy Dock, despite having been lengthened twice, was too small to dock many of the ships visiting Sydney, and the construction of a new dock at the island was approved. An early drawing dated 1882 shows how the dock was designed to accommodate the largest ships then in service in the world, with the entrance of the dock based on the cross section of Brunel's famous *Great Eastern*. In 1870 the management of the dock facilities on the island had passed to the Harbours and Rivers Branch of the NSW Public Works Department and construction of the new dock became the responsibility of commercial contractors.

The excavation contract was awarded to Keogh & Johnston in October 1882. The major contract, for the construction and completion of the dock, was awarded to a young civil engineer, Louis Samuel, who had submitted the lowest of 14 tenders. Sadly Samuel died in November 1887 of acute peritonitis at the age of 26 and his younger brother, Edward, completed the dock. Named after a Minister of Works in an earlier NSW government, the Sutherland Dock was completed in March 1890 and for a short time was, as had been hoped, the largest single graving dock in the world. It was soon overtaken, however, and it was subsequently enlarged on two occasions to enable it to dock the largest ships of the Navy in Australia.



The inside of the convict-built engineering workshop about 1865. The overhead crane has been restored and is still in this building, one of the oldest industrial cranes in Australia. Source: J Jeremy collection.



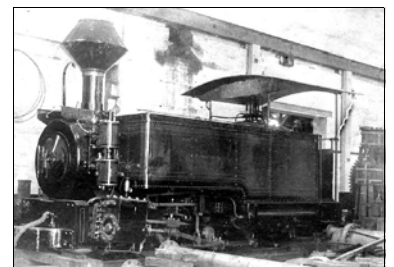
The Sutherland Dock as completed, ca 1893. Source: NSW Public Works Department Annual Report, 1893.

During the latter part of the nineteenth century, engineering facilities on the island were improved and extended, including the provision of foundries and other workshops for the construction of machinery for ships built there, and even the machinery needed to construct them. Over the years engineering work was considerable and varied and included, for example, in the first decade of the twentieth century, cast-iron pipes for the Barren Jack (Burrenjack) Dam in southern NSW. The dockyard also built a steam locomotive and trucks to assist with the construction of the dam.

Federation in 1901 brought the prospect of building ships for the future RAN as well as increasing demand for the engineering and docking services of the island. In 1904 the NSW Government began a modernisation program which was further extended after 1908. It included extension of machine and fitting shops and new shipbuilding facilities on reclaimed land south of the Fitzroy Dock. This new shipyard was ready when plans for the new Australian Navy were developed, including the construction in Australia of four destroyers and a cruiser. After a short competition with Victoria to determine who should build the ships, it was decided that Cockatoo Island should undertake the work, having the necessary facilities and skills for the task.

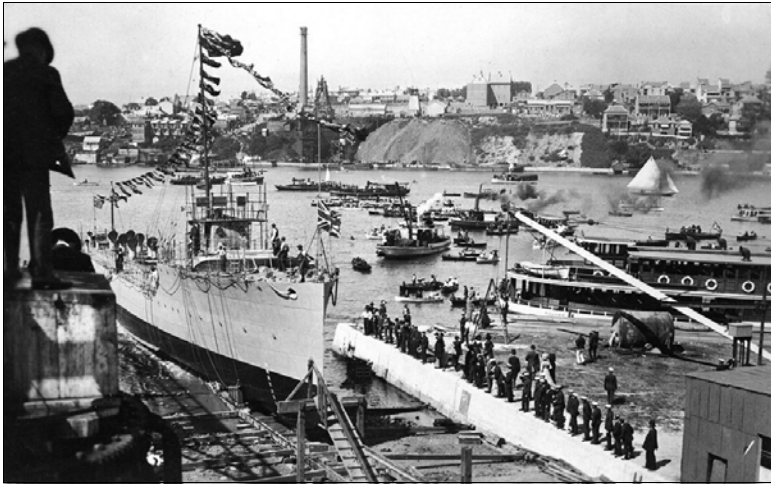
The dock manager, the Harbours and Rivers Branch, had the responsibility of keeping the ports of NSW open to enable the coastal shipping trade, vital to the Colony for its development. Shipbuilding was begun on Cockatoo Island in 1870, on slipways constructed on the eastern shore near the large convict-built engineering workshop. During the time the NSW Government operated the dockyard, over 50 vessels (the records are incomplete), including dredgers, hopper barges, tugs and other small craft were built of iron and wood for the Government. In 1886, the first steel ship to be built in Australia, the tug *Hinton*, was assembled on Cockatoo Island from parts imported from England.

During the latter part of the nineteenth



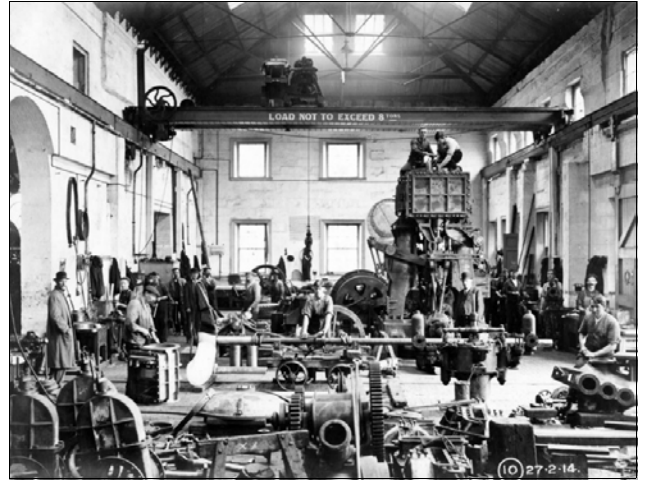
A locomotive built on Cockatoo Island for the construction of the Burrenjack Dam in NSW. Source: J Jeremy Collection.

Cockatoo Island – Industrial Powerhouse

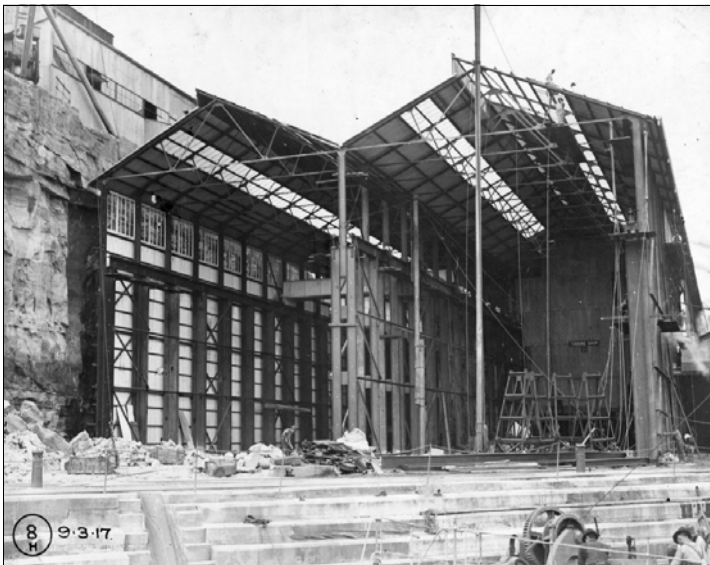


HMAS "Warrego" entering the water at her launching on 4 April 1911.
Source: J Jeremy collection.

Meanwhile, since May 1909 the Commonwealth had been seeking the advice of the NSW Government on a suitable site for a naval dockyard for Australia's new navy. Despite naval objections to Cockatoo Island as that site because of its location (on an island) and its perceived limited facilities, Cockatoo Island was transferred to the Commonwealth (with neighbouring Spectacle Island) on 31 January 1913 for a total price of £867,716 19s, becoming the Commonwealth Naval Dockyard, the first naval dockyard of the new RAN.



The Engine Erecting Shop in 1914. This convict-built building originally housed the dock pumping machinery for the Fitzroy Dock.
Source: J Jeremy collection



Work underway on the extension of the machine shops during World War I.
Source: J Jeremy collection.

With the dockyard the RAN took over the contracts to build the torpedo boat destroyers (*Huon*, *Swan* and *Torrens*) and the cruiser (*Brisbane*). Under the leadership of the new General Manager, John King Salter RCNC², who arrived from Chatham Dockyard in England in 1914, a major development program for the dockyard was begun. The work, carried out by the dockyard itself or by the Naval Works Department which was based on the island, included new wharves, an access tunnel linking the northern part of the island with the dock precinct, new workshops including extensions to the machine and fitting shops, a new forge, tool room and electrical workshop and new amenities for workmen. Extensive rock excavation provided spoil to enlarge the island.

One of the most important projects was to construct a new power station for the dockyard, which was so short of power when the Navy took over that turbo-generators intended for the new cruiser *Brisbane* were temporarily used to supply power to the dockyard. Finally, a new Power Station on the site of the Sutherland Dock pump house was completed in 1920, comprising boilers supplying three 1000 kW turbo-generators, three 1500 cfm air compressors and new dock pumps. The Power Station survives today, 100 years later, with much of the original equipment (but not the boilers and turbo-generators) and a bank of mercury-arc rectifiers installed after AC power reached the island around 1932. Some DC power continued to be used until the dockyard closed in the 1990s. (See image page 10)

² RCNC = The Royal Corps of Naval Constructors, an institution of the British Royal Navy and Admiralty for training in naval architecture, marine, electrical and weapon engineering.

Cockatoo Island – Industrial Powerhouse

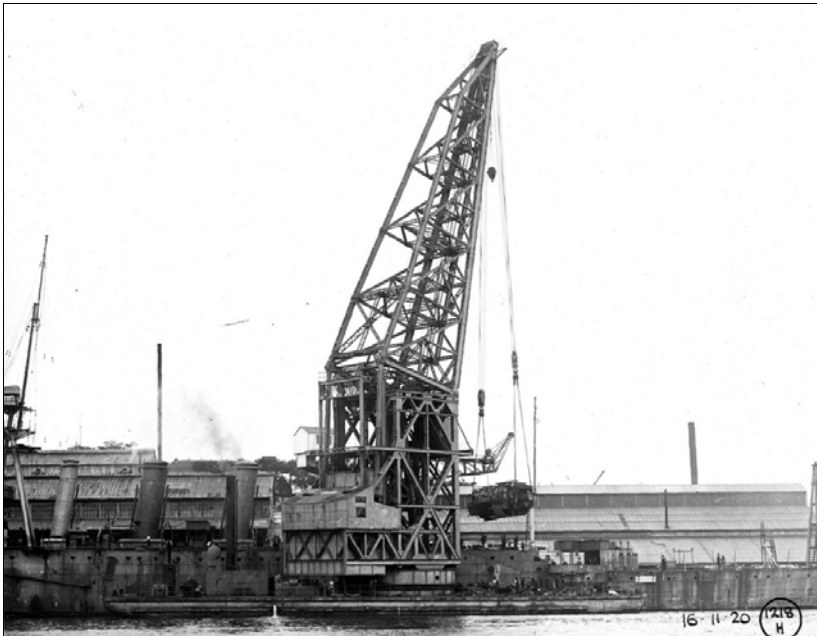
With the outbreak of World War I, the workload of the dockyard increased rapidly. The torpedo boat destroyers and the cruiser HMAS *Brisbane* were completed and the construction of another cruiser, HMAS *Adelaide*, was begun. The dockyard also contributed to the merchant shipbuilding program initiated by Prime Minister W.M. (Billy) Hughes for the Commonwealth Government Line of Steamers which was formed in June 1916. The dockyard did much of the design work and built four of the ships – two Isherwood cargo ships and two refrigerated cargo ships (completed in 1924). The latter, *Fordsdale* and *Ferndale*, were the largest ships ever built in Australia at the time and their boilers and engines were the largest built in Australia.



The launching of the cruiser HMAS Brisbane on 30 September 1915.

Source: J Jeremy collection.

During World War I the dockyard's capacity to handle heavy loads by crane was very limited, despite the NSW Government's investment in the island's facilities in the decade before the war. Capability to handle ships' machinery and other major items on and off the island was desperately needed and in 1916 the RAN ordered a 150-ton lift floating crane, to be named Titan, for use at the Commonwealth Naval Dockyard.



The floating crane Titan installing one of the steam turbines into HMAS "Adelaide" on 16 November 1920. The turbines for "Adelaide", the second cruiser built in Australia, had been made on the island, and it would not have been possible to install them without Titan.

Source: J Jeremy collection.

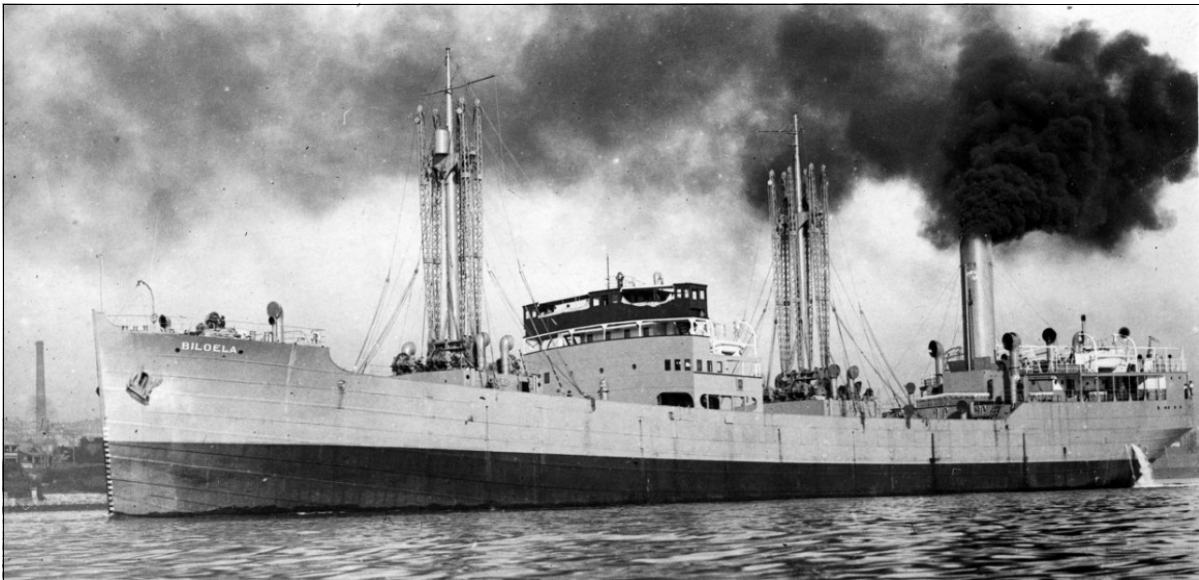
Titan was ordered from Cowans Sheldon and Co of Carlisle and the crane was shipped to Sydney in parts to be reassembled at Cockatoo Island. The design and material for the pontoon of Titan came from Charles Rennoldson of South Shields. Completion of Titan was delayed when the ship carrying the jib screws was sunk by a submarine but Titan was finally accepted for service on 3 December 1919. For the next seven decades Titan was a familiar sight around Sydney Harbour.

In addition to new construction the dockyard completed 21 conversions of requisitioned merchant ships for service as troop transports, many dockings and repairs for Australian and allied ships, and a growing range of engineering work including early steam turbine repair work³, machinery for ships under construction in the dockyard and other Australian yards, many parts for new ships and rolls for the production of steel plate for BHP. Those BHP plate rolls might well have rolled

the steel for the Navy collier *Biloela*, the first ship to be built with Australian-made steel plate, completed at Cockatoo in 1920. (See image next page)

³ For example, Cockatoo Island built new rotors & blading for the turbines of the 1904-built *Loongana*, the first ocean-going steam turbine powered merchant ship in the world..

Cockatoo Island – Industrial Powerhouse



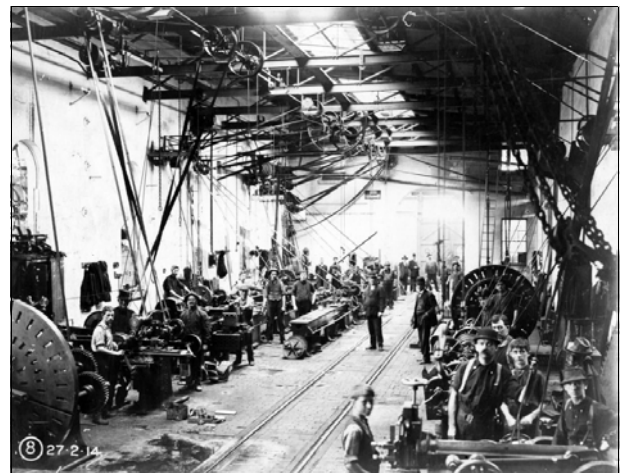
The RAN's collier Bildeola, completed in July 1920, was the first ship to be constructed of Australian-made steel plates.

Source: J Jeremy collection.

With this expanding workload, the workforce grew from about 1500 in 1914 to an all-time peak of 4085 on 31 December 1919. The 1920s were, however very difficult for the dockyard. Employment fell dramatically. Following a Royal Commission in 1921 into the management of the dockyard, the responsibility for Cockatoo Dockyard was transferred from the Navy to the Shipbuilding Board of Control within the Prime Minister's Department.

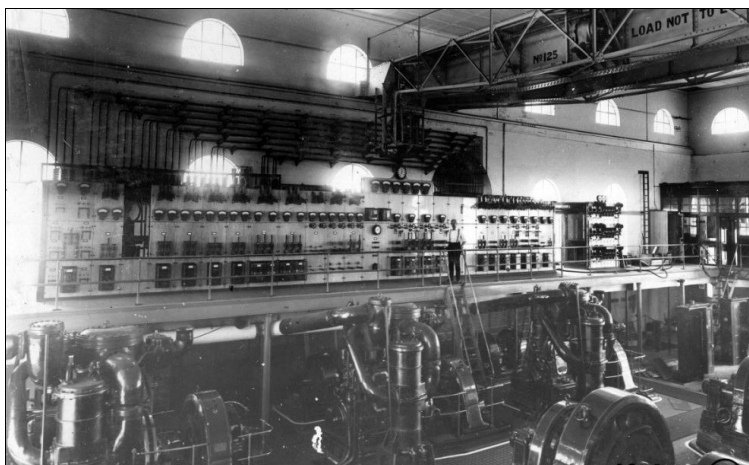
Obtaining work was a high priority for the management and in 1926 the dockyard won a contract from the Sydney Municipal Council to build six turbo-alternator sets for the new Bunnerong Power Station. The contract was lost following a High Court challenge from the unsuccessful bidders and, with only sporadic shipbuilding happening, attempts were made to sell the dockyard. With little evident interest in purchase or lease of the island, negotiations were finally completed in January 1933 for the island to be leased to an Australian private company formed for the purpose – Cockatoo Docks & Engineering Company Limited.

The 21-year lease was backed by a guarantee of a certain level of naval work, and that began a partnership between the Commonwealth, the RAN (ever the principal customer) and the Company, which was to last nearly sixty years.



A nightmare of belt drives - part of the machine shop in 1914.

Source: J Jeremy collection.



The DC switchboard in the new power house, 1920.

The switchboard survives today.

Source: J Jeremy collection.

The Commonwealth provided the buildings, works and services and the Company provided the people and the know-how to run the dockyard. The trading arrangements varied over the decades but usually provided a form of profit sharing between the Commonwealth and the Company, which subsequently only made a loss in one year. The ownership of the Company changed with Vickers Limited taking an interest in 1937 and acquiring the Company outright in 1947. Ownership passed to Vickers Australia Limited in 1978, Comsteel Vickers Limited in 1984 and, finally, Australian National Industries Limited in 1986.

Cockatoo Island – Industrial Powerhouse

The 1933 lease freed the dockyard to undertake commercial work, which grew extensively through the 1930s, although the biggest customer continued to be the Navy. In 1937 the dockyard finally won an order for the Bunnerong Power Station – condensers for its 1937 extension – work which continued until 1939.



HMAS Hobart in the Sutherland Dock during her battle damage repairs in 1943. Source: J Jeremy collection.

By 1939, Cockatoo Dockyard was ready for another period of intense work and expansion. New construction during the war years included three Tribal-class destroyers, eight minesweepers and two frigates for the RAN and two cargo ships for the 1941-formed Australian Shipbuilding Board. Early World War 2 work included high-profile conversions of famous passenger liners into troopships, including the Cunard Trans-Atlantic liners *Queen Mary* and *Queen Elizabeth*. When the war moved to the Pacific region, Cockatoo Dockyard was, for a time, the main ship repair base in the South-west Pacific, and in 1942-43 was very much in demand for repairs to battle-damaged ships like the US Navy cruisers *New Orleans*, *Chicago*, *Chester* and *Portland*. The Australian cruiser HMAS *Hobart* spent a year at the dockyard after having been torpedoed by a Japanese submarine on 20 July 1943. The ship had to be cut in half to realign the stern part of the ship and a complete modernisation was also finished by the time she returned to service at the end of 1944. In the final months of the war the dockyard also carried out many repairs to ships of the British Pacific Fleet and supported the Navy by providing people to help with ship repairs in the new Captain Cook Graving Dock east of the Sydney Harbour Bridge at Garden Island.

Development of Cockatoo Dockyard between 1939 and 1945 included further extension of mechanical workshops with the construction of a new Turbine Shop (still the largest building on the island), a new Brass Foundry, new wharves, another shipbuilding slipway and improved shipbuilding facilities. Most of the work was

justified by the merchant shipbuilding program begun in Australia in 1941 and enabled Cockatoo Dockyard to build machinery and boilers for ships under construction in other yards around Australia. The production of boilers was particularly impressive, with the dockyard making all but 12 of the boilers for warships built in Australia in the war years. In all, 171 boilers were delivered, at one stage at the rate of two per week.

Image Right:

Cockatoo Island Dockyard on 23rd February 1944. HMAS "Hobart" is at the Cruiser Wharf (furthest right), with (moving clockwise) the new destroyer "Bataan" fitting out at the Bolt Shop Wharf, HMAS "Arunta" in refit at the Destroyer Wharf, USS "Gilmer" in the Fitzroy Dock, the River-class frigate "Barcoo" under construction on No. 3 slipway, the floating crane Titan at the Fitzroy Wharf, LST 471 at the Sutherland Wharf, the cruiser HMAS "Australia" in the Sutherland Dock, the cargo ship "River Hunter" under construction on No. 1 slipway and TSS "Nairana" at the Plate Wharf.

Source: J Jeremy collection. Original negative is held by the National Archives of Australia.



Cockatoo Island – Industrial Powerhouse



In preparation for the manufacture of steam turbines for the Daring-class destroyers and the Type 12 frigates, new milling machinery was installed in the machine shops (c1946). Contrast this tidy space with electric motor driven machinery replacing the line-shafting seen in a 1914 photo of the same space (see photo on a previous page). Source: J Jeremy collection.

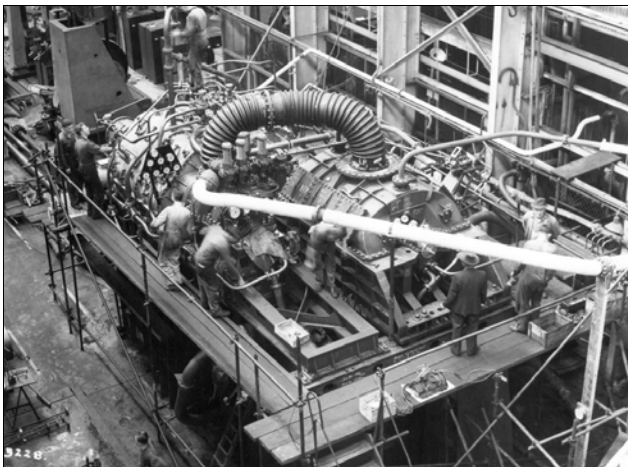
The first Cockatoo-built Daring Class destroyer, HMAS *Voyager*, was completed in 1957. Although electric welding had been used at the dockyard since around 1923, *Voyager* was the first all welded warship built in Australia and dockyard facilities were modified for the purpose, and new machine tools were installed in the machine shops for the turbine construction.

The Daring-class destroyers were followed by a series of Type 12 anti-submarine frigates, but by the 1970s the continuous naval shipbuilding program had withered and naval construction at Cockatoo (and, indeed, Australia) was sporadic for the remainder of

At the end of the war two Australian yards were building the more complex types of warships (Cockatoo and the Williamstown Naval Dockyard in Victoria). The RAN needed a program for the construction of new destroyers after the war, and the Government was very aware of the problems created by a lack of naval shipbuilding capability in Australia in 1939. A continuous program of naval construction was begun, partly justified by the need to retain naval shipbuilding skills. In 1946 four Daring-class destroyers were ordered from Cockatoo and Williamstown, with most of the machinery and armament to be built in Australia. Cockatoo built the boilers and steam turbines for the ships, the latter being the most powerful steam turbines ever built in Australia.



A Propeller manufactured on Cockatoo Island for the destroyer HMAS "Tobruk", c1950s. Source: J Jeremy Collection.



A steam turbine set for the Daring class destroyer HMAS *Voyager* under test. Source: RAN photograph

the dockyard's operation.

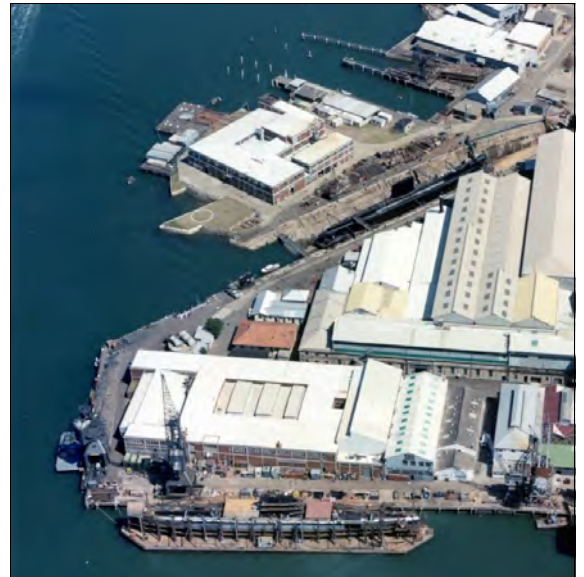
In 1960 a decision was made to re-equip the RAN with submarines and four (later six) submarines of the British Oberon-class were ordered from Scotland. Cockatoo Dockyard was nominated from the outset of the program to be the principal yard for the maintenance and refit of the submarines and in the mid-1960s consultants were engaged jointly by the Navy and the Company to develop plans for construction on the island of modern submarine refit facilities. The consultants were also tasked with planning a major modernisation of the shipbuilding facilities but, in the absence of a major program of new construction to justify the expenditure, only part of the work was completed.

Cockatoo Dockyard was not new to submarines. Australia's first submarines, AE1 and AE2, had visited the island in 1914 and their replacements, the J-class submarines, had been refitted there in 1919 to 1922. Submarines of the Royal Navy's Fourth Submarine Division, based in Sydney, were regular visitors after World War II. In preparation for the Oberon-class refits, Cockatoo undertook five Royal Navy T-class submarine refits between 1961 and 1966. By the time the first Oberon-class submarine refit, of HMAS *Oxley*, began in March 1971 the dockyard possessed among the most modern and complete non-nuclear submarine refitting facilities in the world.

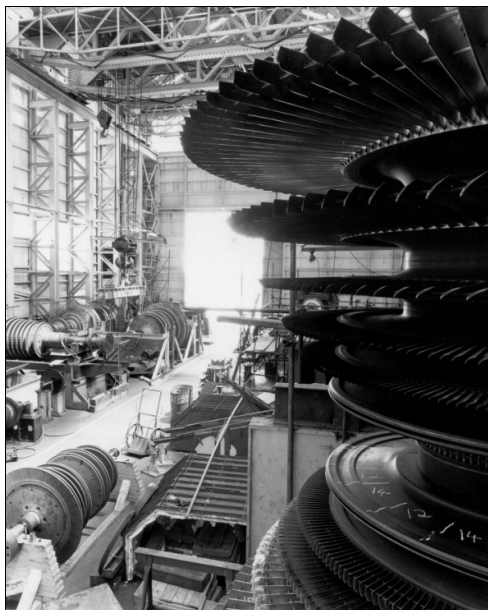
Cockatoo Island – Industrial Powerhouse

The support of the RAN's submarines was the main role of Cockatoo Dockyard in its last two decades of operation. The main refits were major undertakings, taking over two years and about 1.25 million hours of work to complete. In all, the dockyard completed 14 main refits, 15 mid-cycle survey dockings, 39 intermediate dockings and 14 un-programmed dockings of the RAN's submarines. Between 1978 and 1985 the dockyard completed a major Australian-developed and world leading Submarine Weapons Update Program during the refits, a project which helped to engender confidence that we should in future build our own submarines.

Image Right: An aerial view of the submarine refitting facilities - two large new buildings in the south-east part of the island housing the mechanical, electrical and weapons-electrical workshops. An Oberon-class submarine is on the slave dock (foreground), a large pontoon built to accommodate the submarine during the long refit docking period to reduce the load on the graving docks. Another submarine is in the Fitzroy Dock.



Source: J Jeremy collection.



The busy Turbine Shop in the 1980s.

Source: J Jeremy collection.

In 1979 Cockatoo Dockyard began its last shipbuilding project: the construction of the French-designed Fleet Underway Replenishment Ship HMAS *Success*. The largest ship ever built in Sydney and the largest naval vessel yet wholly constructed in Australia, HMAS *Success* was to give 34 years of service to the RAN following her completion in 1986. During her construction, employment reached a peak of 2650 (including 410 apprentices) and, in addition to the submarine work and the shipbuilding, the dockyard continued to carry out a wide range of commercial work, including steam turbine repair for customers throughout Australia and the South-west Pacific.

In 1987, following a review of Commonwealth-owned dockyards in Australia, the need for them, and their condition, the Government decided not to renew the then current lease of Cockatoo Island which was due to expire at the end of 1992. Following a turbulent period of industrial unrest, the last submarine refit, that of HMAS *Orion*, was completed on 4 June 1991. The remaining period of the lease was spent decommissioning the dockyard and disposing of dockyard plant, equipment and buildings, effectively destroying a fully operational facility.

Today, Cockatoo Dockyard is no more, but its record over 134 years in peace and war remains, a remarkable contribution to the development and support of the Navy in Australia and Australia's industrial development. At least 360 ships, boats and other craft were built at Cockatoo Island between 1870 and 1987 and between 1857 and 1991 an estimated 12,000 dockings and slippings of a wide range of vessels were undertaken at the dockyard, more than at any other facility in Australia. It is a remarkable record.

Now the responsibility of the Sydney Harbour Federation Trust, Cockatoo Island is in their good hands as custodian for the people of Australia, who may now visit at any time, hopefully to absorb some of the history of the place during their visit.

Image at Right: The dockyard fabricated seventy 47-tonne mill shells for the coal pulverising mills at Bayswater, Eraring and Mount Piper power stations in NSW. Here one is being machined in the dockyard's largest lathe.



Source: J Jeremy collection.

Cockatoo Island – Industrial Powerhouse

The author

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Bibliography

The industrial history of Cockatoo Island has been extensively recorded. When the dockyard closed, a very large collection of surviving drawings, plans, documents and photographs relating to the island, its plant and facilities and the ships built and repaired there, were transferred to the custody of the National Archives of Australia.

Relevant references to the industrial history of the island include:

- Chambers, M. (2000), *Cockatoo Island Dockyard: A Guide to the Records*, National Archives of Australia, Canberra.
 Dinnie, W.D. (2016), *Cockatoo Dockyard: My Story*, privately published, Sydney.
 Hobbs, R. (2017) *A Shipwright in the Colonies: John Cutburt 1815-1874*, privately published, Canberra.
 Jeremy, J. (1998, reprinted 2005), *Cockatoo Island: Sydney's Historic Dockyard*, UNSW Press, Sydney.
 Jeremy, J. (2013), *The Island Shipyard: Shipbuilding at Cockatoo Island 1870 to 1987*, Sydney Harbour Federation Trust.
 Jeremy, J. (2013), *Keeping the Ships at Sea, Ship Repair at Cockatoo Island 1857-1991*, Sydney Harbour Federation Trust.
 Parker, R. (1977), *Cockatoo Island*, Thomas Nelson (Australia) Ltd, Melbourne.



The last ship built at Cockatoo Island, the fleet underway replenishment ship HMAS Success, leaving the dockyard for hand over to the RAN on 15 April 1986. Source: J Jeremy collection.

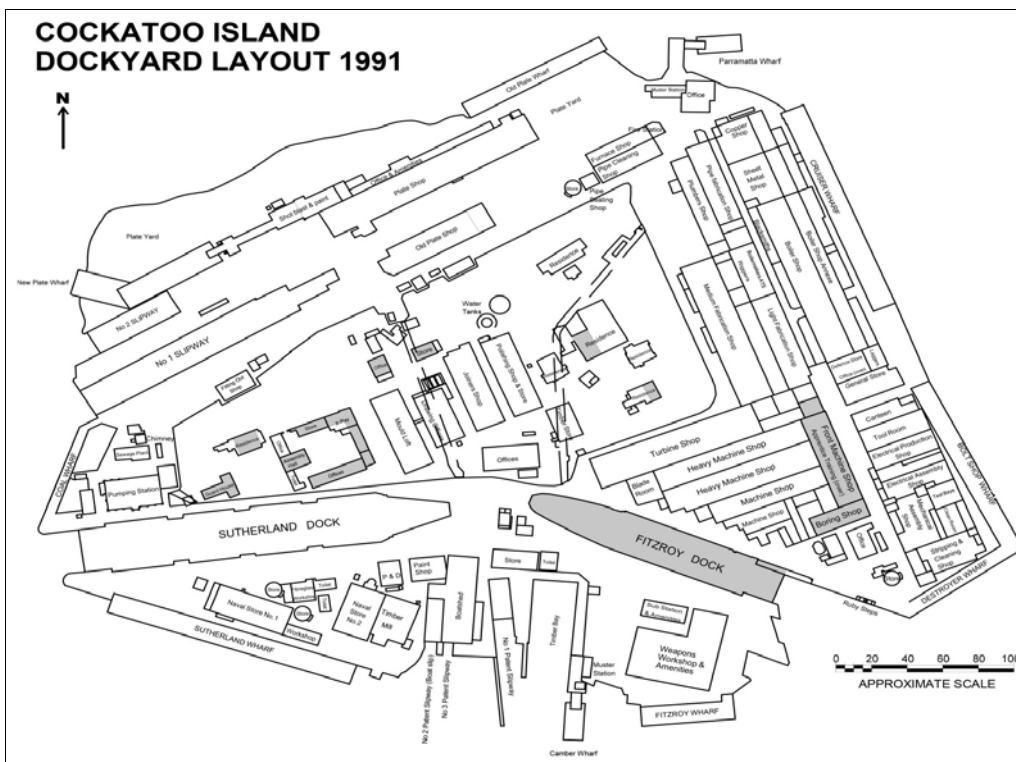


Image at Left:

This plan of the buildings and structures in existence on Cockatoo Island in 1991 was provided by the author, who shaded the surviving convict built structures and buildings in grey.

These include the Fitzroy Dock, the original Engineering Workshops (here labelled "Front Machine Shop and Boring Shop"), a number of offices and stores, an Assembly Hall, a Guard House, and parts of three existing residences.

To the left of the Guardhouse, alongside Sutherland Dock, the 1920 Power Station (here labelled "Pumping Station") stands out with its orange roof and tall chimney, in the cover photo.

Unfortunately, the lettering on the buildings is very small, but the drawing may be enlarged on screen enough to read the words, which indicate the use of each building as in 1991.

The Editor.

A Black Summer for Victoria's Bridges

By Helen Martin.

The fires that swept through eastern Australia in the summer of 2019-20 destroyed over 400 houses in East Gippsland Shire in Victoria, and also consumed three and a half of East Gippsland's historic bridges. Two of the structures lost were Howe truss road bridges, both on the Victorian Heritage Register (VHR). The third was a smaller timber-beam road bridge listed under the Heritage Overlay in the Shire's planning scheme. None had been in use for traffic. The 'half' is a handsome composite timber-iron rail trestle bridge, not heritage listed despite

being assessed in 1997 as State-significant. Several smaller wooden bridges that had not been assessed for heritage significance were also burnt.



Princes Highway bridge over the Genoa River, 1952. Source: Vic.Railways Collection - State Library of Victoria - <http://handle.slv.vic.gov.au/10381/291351>

Genoa River truss bridge

Perhaps the most serious loss was the 1928 three-span truss bridge over the Genoa River, at Genoa near the New South Wales border. Until 1989 this was where the Princes Highway crossed the river. The Genoa River truss bridge was heritage listed in 1995 and restored in 1997 after a community campaign, as a pedestrian link between the camping park on the northern bank of the river and the Genoa township.¹

The VHR statement of significance describes the bridge as follows:²

The 100 metre long timber truss and concrete bridge over the Genoa River at Genoa is a parallel girder truss bridge with a hybrid structure comprised of reinforced concrete piers, timber superstructure and timber piled abutments. The bridge was built between 1926 and 1928 by contractor J.T. Noble Anderson to a design by the Country Roads Board. . . . Alterations to the bridge have included a realignment of the timber decking . . . from transverse to longitudinal and the introduction of some steel supports for the decking. In 1989 the bridge was replaced by a new set of structures 130 metres downstream.

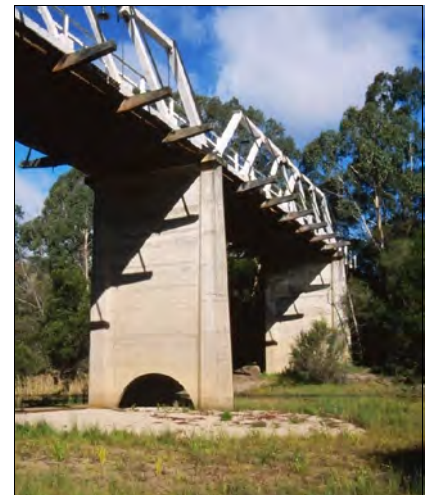
The significance of the bridge was assessed as follows:

The timber truss and concrete bridge over the Genoa River at Genoa is of scientific (technological) and architectural importance as an unusual, large and early example of hybrid concrete and timber bridge construction. The bridge is of historical significance as a crucially important link in the Princes Highway route from Melbourne to Sydney. It was the third bridge on this site and its hybrid design is historically important as a manifestation of the rising importance of motorised traffic in the 1920s which necessitated the added strength of concrete in the substructure; the retention of a timber superstructure reflects the traditions of timber bridge building in remote localities.³

The National Trust of Australia (Victoria) (NTAV) registration classification report for the bridge says:⁴

The Genoa Truss Bridge is Victoria's only "Highway Bridge" of the type illustrated by the road-and-bridge construction manuals from early this [20th] century. It also expands on the significance of the contractor: The contractor who undertook the bridge's construction was J.T. Noble Anderson who pioneered concrete construction with John Monash and became Victoria's most famous exponent of concrete-road construction . . .

Image at Right: Genoa River truss bridge, decking (with shadows) looking south, 2003. Source: B. Martin for East Gippsland. Shire.



Southern piers of the Genoa Bridge, seen from the river bed.

Source: B.Martin for East Gipps. Shire.



1 A plaque installed on the bridge reads: *Genoa Bridge - built 1928, heritage listed 1995, restored 1997. This plaque commemorates the pioneers of Genoa and district - past and present - who have travelled across this bridge on foot, by horseback and motor transport, and pays tribute to those who fought bureaucracy to save this unique structure from demolition and persevered to achieve its restoration. Funded by VicRoads and Heritage Victoria.*

2 Timber truss and concrete bridge over Genoa River – Victorian Heritage Database – <https://vhd.heritagecouncil.vic.gov.au/places/4416>

3 Ibid.

4 Included with a letter from NTAV to EGSC, 5 February 1997. See also <https://vhd.heritagecouncil.vic.gov.au/places/67916>

A Black Summer for Victoria's Bridges



The township end of the Genoa bridge, showing the new narrow steel-decked pedestrian gangway across the failed timber abutments. In the foreground, a short part of the strip of new longitudinal decking is chained off from the old, probably unsafe, decking timbers. Source: H.Martin.

Richard Peterson, in a 2006 Conservation Management Plan for the Murrindal River truss bridge (see below) says that the Genoa bridge was designed by D.V. Darwin and T.H. Upton. Darwin was a very eminent Victorian bridge engineer, who eventually became chairman of the Victorian Country Roads Board (CRB).⁵

Around 2010, when the abutments began to fail, the Genoa River bridge was modified to provide pedestrian gangways at either end and to restrict walkers to a section of renewed decking.

The fire that burnt along the coast to Mallacoota on 31 December 2019 spread inland to Genoa, destroyed the former Genoa State School and then swallowed up the truss bridge.

A few weeks later the East Gippsland Shire — Bushfire



Genoa River bridge, showing cracks in the base of a leaning concrete pier, 2011. Source: East Gipps. Shire Council.

Community Newsletter reported:⁶ *Genoa truss bridge pier demolition: The bushfires claimed a significant piece of infrastructure – the Genoa truss bridge [. . .]. The deck was destroyed, and the main piers also suffered significant cracking at the base. The cracking has increased, and piers have started to lean considerably. This is a significant and immediate safety hazard, as the riverbed is freely accessed by members of the public. With the approval of the Orbost Incident Control Centre a contractor has been engaged by Council to undertake a controlled demolition of the two failed piers into the riverbed. We appreciate there will be many people in the community who have a connection with the historic bridge and the purpose it serves in the community, however this action is necessary for public safety. Demolition occurred immediately afterwards. In August 2020 East Gippsland Shire called tenders for a replacement pedestrian bridge.*



Genoa River bridge with decking on fire, 31 December 2019. Source: ABC Gippsland website.

Murrindal River truss bridge

The second VHR-listed bridge lost was a lovely single-truss structure over the Murrindal River on the Basin Road at Buchan East, built in 1927. The VHR statement of significance (c2012) describes it as follows:⁷

This six-span Murrindal River bridge consists of five stringer approach spans of thirty feet (9.1 m) and one eighty foot (24.5 m) timber Howe truss span of a standard CRB design. This simple truss design was suited to fabrication in remote areas and was used extensively from 1919 to the late 1920s. The western approach spans are widened and gently curved. The transverse deck remains in place and is unusual in that the timbers are spaced approximately half their width apart, possibly to improve longevity. Until recently the deck was topped by two strips of running-planks for motor vehicles, but it is now completely covered in longitudinal planks. The timber trestles supporting the truss and the girder approach spans are supported on mass concrete piers. True timber trestles, as found here, are rare in Victoria. The outer ends of the approach spans are supported by buried timber piers . . . The bridge is now closed to vehicular traffic and has been made suitable for pedestrian use, with a new concrete road bridge built upstream.

5 Richard Peterson, architect and conservation consultant *Murrindal River Bridge, Basin Road, Over the Murrindal River, East Buchan: Conservation Management Plan. March 2006. Revised June 2006.*

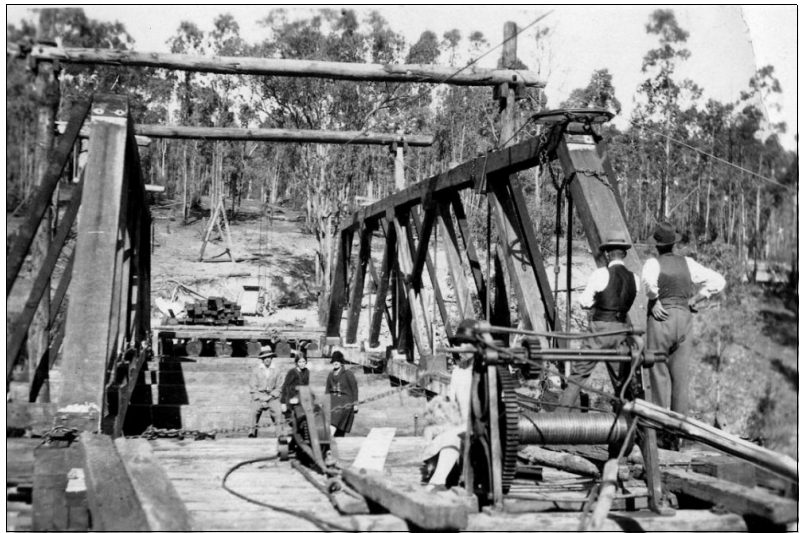
6 East Gippsland Shire *Bushfires 2019-20 Community Newsletter, 22 January 2020 - Edition 8.*

7 Victorian Heritage Database - Murrindal River truss bridge <https://vhd.heritagecouncil.vic.gov.au/places/13058>

A Black Summer for Victoria's Bridges

The Murrindal River bridge was constructed under the Developmental Roads Act 1918 and built under direct CRB supervision. The CRB described the bridge in its Annual Report as 'virtually a viaduct'.

The VHR statement of significance assessed the bridge as of scientific (technological), historical and aesthetic significance to the State of Victoria as a rare example of a timber truss bridge – one of four [actually only three] timber truss bridges remaining in the State – and a rare and intact example of a timber Howe truss span made to a standard CRB design. Its significance was enhanced because it was accompanied by timber stringer approach spans and timber trestle supports, which were consistent with the timber technologies that accompanied most of the single truss spans built in the State.⁸



Construction of the Murrindal River truss bridge at Buchan East in 1927. Harold Lewenden, a worker on the bridge, is seated on the bridge deck.

Source: Lewenden family collection via Rhonda Coates.



Murrindal River truss bridge, Buchan East, 2004.

Source: Tim Gibson for East Gippsland Shire Council.

Richard Peterson, in his 2006 Conservation Management Plan (prepared for East Gippsland Shire), says that this bridge was designed and the drawings signed by D.V. Darwin, who also designed the Genoa River bridge.¹⁰



The Murrindal River bridge after the fire, January 2020. Source: EGSC.

The Murrindal bridge was damaged severely by an overweight livestock transport during the 2003 fires. It was strengthened with a steel beam to support the failed southern truss, but was only capable of carrying light vehicles. It was replaced with a steel and concrete bridge, built nearby, in c2006. The bridge was destroyed in the fire that burned through the town of Buchan and surrounds on the night of 30 December 2019.

The Murrindal River bridge was historically significant as a representative example of the types of works funded by the CRB under the Developmental Roads Act. The bridge and the associated roadworks were a very substantial investment in a road that serviced a small and otherwise-isolated hinterland. As such it was representative of the goals of the Act. Its aesthetic significance derived from its placement in a striking high-country landscape setting, on a winding road, crossing a fast-flowing river in a steep-sided wooded valley and with an impressive hilly backdrop.⁹



Murrindal River truss bridge decking, Buchan East, 2004.

Source: Tim Gibson for East Gipps. Shire Council.

8 Victorian Heritage Database - Murrindal River truss bridge <https://vhd.heritagecouncil.vic.gov.au/places/13058>

9 *ibid.*

10 Richard Peterson, *ibid.*

A Black Summer for Victoria's Bridges

Bete Bolong Creek bridge, Buchan-Orbost Road, Bete Bolong North

The National Trust of Australia (Vic.) classification report (c1998) on the Bete Bolong Creek bridge describes it as *a four-span all-timber pile-and-stringer bridge, with gently-curving transverse-timber deck topped by running planks*. It was built in 1930 to CRB plans. The road was constructed under the Developmental Roads Act but there was also a substantial Commonwealth contribution.¹¹

The bridge was assessed as historically and aesthetically significant at a State level¹²: *It is an extremely rare and unusually authentic example of a traditional Victorian transverse-decked timber-beam bridge with a horizontally-curving deck to accommodate a road bend at a stream crossing . . .*



Bete Bolong Creek bridge, Bete Bolong, undated but probably c1997. Source: National Trust (Vic).



Bete Bolong Creek bridge, showing the curved decking and the new steel and concrete bridge alongside, 2003. Source: H. Martin for EGSC.

The humble timber-beam or 'pile and stringer' type of bridge has played a major role in Victorian bridge history, but this bridge's combination of curving timber deck with transverse-timber decking topped by longitudinal 'running planks' is believed to be unique in Victoria. The Country Roads Board changed to a standard longitudinal timber deck after 1931, the superstructure design of this bridge represents the end of an era in timber bridge design Bete Bolong Creek Bridge's rare curve-deck timber structure stands some six metres above stream level, on a sharp bend on a twisting hilly road . . . The Bete Bolong Bridge's very unusual neatly-curving timber frame enhanced by its four-span design, the height of its four-pile timber piers, the old-style transverse-deck with running planks, and attractive rural setting combine to make this modest timber bridge a very attractive structure.



Around 2000 a steel and concrete bridge was constructed on a parallel alignment and the timber bridge became redundant.

The timber bridge was completely destroyed in the bushfires on 30-31 December 2019.

Image at Left: The sad remains of the Bete Bolong Creek bridge, Bete Bolong North, after fires, January 2020. Source: Carrol Preston, Gippsland History.

*O'Grady's Creek / Wairewa Road rail bridge, on the Bairnsdale to Orbost rail line.*¹³

The rail bridge over the Wairewa Road, known historically as the O'Grady's Creek bridge, uses metal girders resting on tall timber piers to support a transverse timber deck. It consists of 21 spans and is 140 metres long. It is relatively unusual in crossing a roadway as well as a creek and also has a substantial curve. Like the Boggy Creek bridge at Nowa Nowa – also in East Gippsland – the main girders are wrought iron plate girders recycled from an 1874 North Eastern (Melbourne to Albury) Railway bridge – probably from the Broken River Bridge at Benalla, where the iron girders on the approach spans were replaced with steel in 1912 to allow it to take heavier locomotives.

11 Included with a letter from NTAV to EGSC, 13 August 1998. See also <https://vhd.heritagecouncil.vic.gov.au/places/67876>

12 *ibid.*

13 See *Catching a Train from Orbost – Building the Bairnsdale to Orbost Railway in Eastern Victoria – 1912 to 1916*, from Helen Martin and the Editor in EHA Magazine, Vol.1, No.5, December 2014.

A Black Summer for Victoria's Bridges

The O'Grady's Creek / Wairewa Road rail bridge featured in Don Chambers's book *Wooden Wonders* (2006)¹⁴, but despite its size, beauty and apparent good state of repair it had fallen off the NTAV register. Fortunately it was restored to the Register relatively recently. The Wairewa bridge was assessed as State significant in the NTAV wooden bridges study in 1997.¹⁵ It is not included in the East Gippsland Shire's Heritage Overlay, because the NTAV did not provide information on it, nor was it nominated for the VHR when the other significant bridges on the rail line were put up for the Register in 2014.



O'Grady's Creek rail bridge, structure from western end, Wairewa, 2009. Source: H. Martin.

The Bairnsdale to Orbost rail line was closed in 1987 and the rails were taken up in the following decades. A Rail Trail was constructed along the rail corridor in the late 1990s but most of the bridges are bypassed.

The *Friends of the East Gippsland Rail Trail* were hoping to attract funds to restore the bridge as part of the rail trail, but decided to concentrate first on the Snowy River floodplain viaduct, which is more visible and less expensive to repair. (Substantial funding was allocated for that bridge in a recent State budget.)



O'Grady's Creek rail bridge under construction, 1914-15. Source: Charles H Perrin collection - Vic. Railways - Museum Victoria

During the night of 30-31 December 2019, a tongue of fire raced down the valley west of the Wairewa Road and took hold of the bridge. A CFA fire truck deployed to East Gippsland from the Wendouree Brigade (near Ballarat) reached it in time to save the eastern half of the bridge. Contractors for DELWP (Victorian Department of Environment Land, Water & Planning!) are now working to stabilise the remaining portion of the bridge and to construct a viewing platform, parking area and new visitor amenities in the area.



Image Above: O'Grady's Creek rail bridge, Wendouree CFA Brigade dousing the fire, Wairewa, 31 December 2019. Source: CFA website.



Image at Right: O'Grady's Creek rail bridge, eastern end after fires, Wairewa, January 2020. Source: Helen Martin.

Victoria's only remaining timber truss bridge

For those who are wondering, the only remaining timber truss bridge in Victoria is also in East Gippsland Shire. It is the VHR-registered 1910 Hinnomunjie bridge, originally known as the Mitta bridge, in the Omeo Valley.¹⁶ It had its own brush with fire in 2003 and was unable to be repaired for long-term vehicular use. A new bridge was built on a parallel alignment c2006. At present, funding is being sought to restore the Hinnomunjie truss bridge for pedestrian use, including removing the heavy steel beams and props added as a temporary measure after 2003. Stay tuned for updates!

14 Don Chambers (2006) *Wooden Wonders: Victoria's Timber Bridges*, Hyland House Publishing for the National Trust of Australia (Victoria).

15 National Trust of Australia (Victoria) classification report, *Wairewa Road Railway Bridge*, c1997.

16 Victorian Heritage Database - Hinnomunjie Bridge <https://vhd.heritagecouncil.vic.gov.au/places/894>

Sydney's Earliest Public Water Supplies

The Tank Stream and beyond – the Public Water Fountains

By Tony Brassil

Introduction

The early water supply of Sydney is usually recognised as having the following stages:

1. Arrival and settlement beside the Tank Stream (1788 - 1790);
2. Cutting of tanks adjacent to the stream to hold water in reserve (1790 - 1795);
3. The gradual pollution of the Tank Stream over the ensuing two decades (1795 - 1826);
4. Opening of Busby's Bore, from Lachlan Swamps (ie Centennial Park) to the city of Sydney. (1826 - 1850s);
5. The replacement of Busby's Bore by the Botany Water Supply Scheme, utilising water from the Lachlan and Botany Swamps (1850s - 1880s); and
6. Replacement of the Botany Water Supply by the Upper Nepean Water Supply Scheme (built 1880-1888, the 1948-1960 Warragamba Dam and the recent Kurnell Desalination Plant.

However, there is more to this story. . .

The Tank Stream

The selection of Sydney Cove for the site of the English convict settlement forms a fundamental part of the European history of New South Wales. As glowingly described by John Stockdale in the seminal *The Voyage of Governor Phillip to Botany Bay*, published in London in 1789: *The different coves of this harbour were examined with all possible expedition, and the preference was given to one which had the finest spring of water, and in which ships can anchor so close to the shore. . . . This cove is about half a mile in length, and a quarter of a mile across at the entrance. In honour of Lord Sydney, the Governor distinguished it by the name of Sydney Cove.*



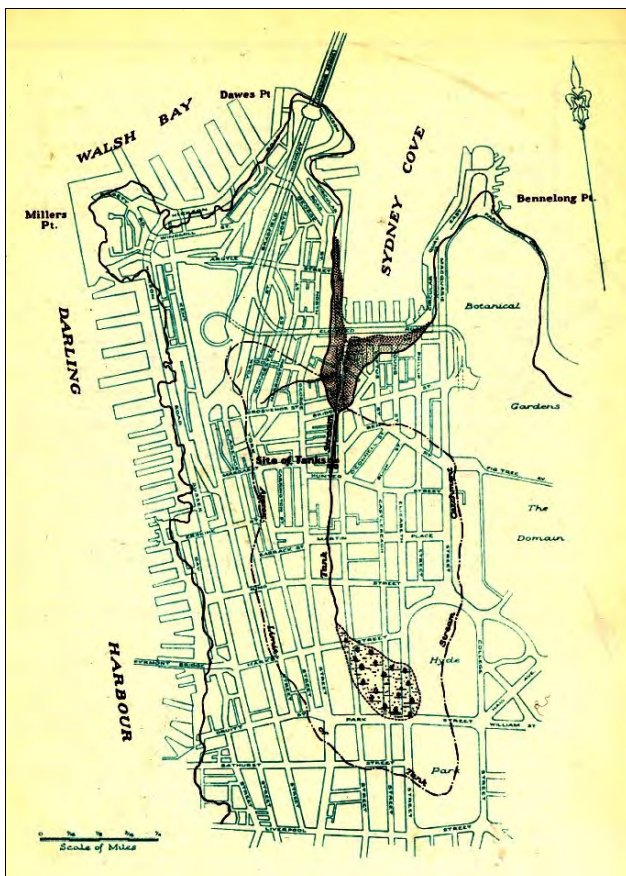
Sydney Cove in 1803 (detail), attributed to G.W. Evans.

Source: State Library of NSW.

This stream, as yet unnamed, performed a second function when the settlement was then laid out in two parts, on opposite sides of the stream. The Governor's Residence, the residences of all of the senior military and civil officers and the important Naval and military stores were located on the eastern side; the soldiers, convicts and the utilities of the town (ie the storehouses, hospital, lumber yard and marketplace) were established on the western side. This separation was both social and practical – the senior officers and the 'administrative class' were separated from the hurly-burly of the working-class soldiers and convicts; equally, the prevailing winds in Sydney throughout summer are from the east, meaning those on the east of the stream breathed fresher, less odorous air.

In 1790, owing to a long period with little rain, several rectangular 'tanks' were cut into the bedrock of the stream to act as reservoirs and, as early as 1791, Governor Phillip enclosed the Tank Stream with a fence to prevent stock muddying the water. In 1795, Governor Hunter made orders to prevent the grazing of stock or cutting of trees within a 15 metre distance of the stream. Later still, trenches were cut alongside the stream in an attempt to catch polluted runoff before it could enter the waterway.

Image: The course & catchment of the Tank Stream, superimposed on a street plan of modern Sydney.
Source: W.V. Aird's History of the Sydney Water Board, 1964.



Sydney's Earliest Public Water Supplies

Subsequent Governors continued to attempt to preserve the Stream but, despite their injunctions, the stream and the quality of its water continued to deteriorate. However, as it turns out, the Tank Stream wasn't the only source of water during these years.

Public Fountains

A key document in the search for Sydney's early water sources is the *Plan of the town and suburbs of Sydney, August, 1822* held by the National Library of Australia¹. This map includes a numbered list of items of interest and importance in the town and has, as Item 66, a reference to *Fountains*. The plan shows two '66s', one at Macquarie Place and one within Bent Street at the end of O'Connell Street (although these Streets are not named in this plan, they were named by the time it was drawn).

So — what were these 'Fountains' in old Sydney Town? — As it turns out, these two fountains were quite significant in the early settlement.

Image at Right: Detail from James Meehan; "Plan of the town & suburbs of Sydney", August 1822. The Bent St Fountain is on the right, the Macquarie Place one on the left. Source: National Library of Australia.



The Bent Street Fountain

The Bent Street Fountain first appears in the public records in October, 1810, in a public announcement by Governor Macquarie renaming the major streets of Sydney². In the list of streets, No.17: *Bent Street* is described as *extending from Spring Row in an easterly direction to the Fountain, and thence to the north end of Phillip-Street*. In 1811, in a news report regarding the on-going drought, the *Sydney Gazette* recorded that:

*In Sydney the Tanks have been several weeks empty, and those who were in want of water obliged to collect it from small cavities in the spring course above the Tanks, which has afterwards been sold at from four-pence to six-pence per pail.*³

In 1812, a report on the Accounts of the Colony includes, in its list of expenditures, a sum of 88 pounds paid to Isaac Peyton *for erecting a new public fountain in Bent-street*⁴. In 1815, Edward Cureton was paid 5 pounds *for repairing the Fountain in Bent Street*⁵.

These references are given considerably more weight by a Government Proclamation of 31 August, 1816:

1. HIS EXCELLENCY the GOVERNOR having caused a large Stone Cistern, or Reservoir to be constructed adjoining the Fountain, in Bent street, in order to receive the surplus Water from thence, and a Pump having been placed thereon for the Use and Accommodation of the Inhabitants of Sydney, and these Works having been completed at a considerable Expence to Government; . . .

2. In order to guard the more effectually against any Part of the Fountain, Reservoir, and Works attached thereto, being injured by Cattle, or Carriages coming in contact therewith, His EXCELLENCY has ordered the Whole to be enclosed with a strong Palisade, having a Gate for Persons to enter at for Water; but at which no Cattle of any Description are on any Account to be permitted to enter.



Detail from 'Sketches of Sydney, 1843 - 1847' by Jacob William Jones, showing the Bent St. fountain, viewed looking across Bent St, and south-west into O'Connell Street. Note the man carrying a pair of buckets in the right foreground. The large building on the left was a private house then the Pulteney Hotel and later became the Australian Club. Source: State Library of NSW).

1 Meehan Jas. *Plan of the town and suburbs of Sydney, August, 1822*; NLA Call No: MAP F 107.

2 The *Sydney Gazette and New South Wales Advertiser*; Sat 6 Oct 1810; Page 2: *Plan of the New and Old Names of Streets, Etc. in the Town of Sydney; with Explanation and References*.

3 The *Sydney Gazette and New South Wales Advertiser*; Sat 2 March 1811; p 2: *Sydney*.

4 *ibid.*; Sat 18 April 1812; Page 2: *Government Public Notice*.

5 *ibid.*; 05 Aug 1815; Page 1: *Government and General Orders*.

Sydney's Earliest Public Water Supplies

The Sydney Gazette, in its weekly round-up of news that week, includes this passage:

The fountain opposite the north end of O'Connell street, which by the orders of His EXCELLENCY the GOVERNOR has been neatly inclosed within a palisade, is an interesting addition to the great scale of improvement which every quarter of the town exhibits to the view. A few years back, the spring that now supplies this beautiful and comparatively capacious reservoir, lavished its transparent stream beneath a little rock unheeded but by a few of the contiguous inhabitants. During seasons of intense drought it remained unnoticed, and continued to be unserviceable until the crystal purity of its waters obtained from Government the attention to which it now prefers so just a claim. The first receptacle, or stone octagon prepared for it, which contained several tons of water, has received the addition of a much larger cistern, in the centre of which is placed a fine pump, by means of which the largest vessels brought are filled without delay and many are thither invited by the salubrity of its waters, from the most distant parts of Sydney.⁶

The Sydney Gazette's article, at least, explains that this fountain tapped an existing perennial spring, one of the branches feeding the Tank Stream. It is only a small leap to suggest that 'Spring Street' may well owe its name to this watercourse. It is also clear from the earlier references that this spring was well known and considered to be a 'fountain' already by 1810.

This 'fountain' may, or may not, be related to a description in Stockdale's publication that: *The scantiness of the stream of fresh water was thought at first unfavourable, but good spring water has since been found by digging. The house built for Governor Phillip stands about fifty six feet above high-water mark, and there, by sinking a well about fifteen feet in the rock, an excellent spring of water has been obtained.⁷*

In 1826, work commenced on the construction of Busby's Bore, a tunnel to bring water from the Lachlan Swamps (now Centennial Park) to the city. By 1830, a pipe at Hyde Park began to supply water obtained from the tunnel, delivered into water carts for distribution. In 1837, construction work on the tunnel was completed and, commencing in 1844, reticulation pipes were laid around the town, supplying houses, businesses and a large number of 'public fountains'. A plan of the water pipework in 1844 shows pipes leading to the site of the Bent Street Fountain (and to the Macquarie Place fountain). With a general public water supply in operation, the old fountain was converted to a public drinking fountain.



An advertisement on a card for the Pulteney Family Hotel, in Bent St Sydney. Artist, William Moffit in 1834. I (the Editor) liked this image, with the charming inclusion of the Bent St Fountain - obviously the most important landmark locating the hotel! Source: National Library of Australia.



No images, plans or drawings of Macquarie's arrangement of stone octagon, cistern and palisade fence have been discovered. However, the stone octagon is readily visible in many images of Bent St produced throughout the mid-nineteenth century. The earlier images (pre-1860s) show the octagon comprising a low stone wall surmounted by eight classical columns supporting an octagonal domed roof. A gap in the wall between two columns on the western side allowed people to enter the octagon to obtain water. In all of these images, the Octagon is alone, with no obvious reservoir, cistern, pump or palisade fence.

Later images of the Bent St Octagon show that the open arches had been filled in and water bowls had been fitted into some of the faces of the Octagon. It appears that this occurred in 1862. The Octagon survived as a local amenity and landmark until circa 1905, when it was removed for the installation of tram tracks in Bent Street.

Image Left: "A One-Time Street Fountain, Bent Street" by Sydney Ure Smith; from "Illustrations for book: Old Sydney, 1911". The Stone Octagon had been demolished for approximately six years in 1911, when this image was published. It shows the arches filled in, one visible water bowl on the side, and a door installed in the opening at the front.

⁶ *ibid.*; 19 Oct 1816; Page 2: *Sydney*.

⁷ Stockdale, J; *The Voyage of Governor Phillip to Botany Bay, London, 1789*. Digital Edition: University of Sydney Library; Sydney; 2003.

Sydney's Earliest Public Water Supplies

The Macquarie Place Fountain

The Macquarie Place Fountain is better known than its Bent Street counterpart, partly owing to the fuss its construction caused. In 1819, Edward Cureton, Stonemason, was contracted to erect a fountain in Macquarie Place, for which he was part paid in March 1820⁸ and July, 1820⁹.

However, Commissioner Bigge arrived in 1819 and, among other things, was extremely critical of Macquarie's elaborate buildings and monuments, especially the fountain. According to the evidence of Edward Cureton, Francis Greenway and Elizabeth Macquarie to Commissioner Bigge, Cureton had been building the fountain slowly, on Saturdays only, until the walls were 14 feet high, out of their projected 24 feet, to a design supplied by Elizabeth Macquarie. Elizabeth Macquarie had then instructed Cureton to cease work and recommence to a new design by Francis Greenway that would be only 14 feet to the top of the dome.



This image, painted by Conrad Martens in 1839, comes with the description: "The villa in a park with exotic trees, demarcated by a fence, in the foreground dark skinned figures next to a fountain monument".

Source: Catalogue HAMPEL Fine Art Auctions Munich.

In any case, the fountain appears to have been completed in 1820, as a square pavilion with a domed roof and with arched openings on each side, the western opening being a full-height doorway. It stood on a square stone plinth in the south-western corner of Macquarie Place. Governor Macquarie listed *A Handsome Stone Fountain erected over a Spring in Macquarie Place for supplying that part of the Town with Water* in his list of accomplishments at the end of his term as Governor.¹⁰

The source of water for the Macquarie Place Fountain remains unclear; there is no other mention of a natural spring in this vicinity and the location is low and close to the waterfront. It is likely that what Macquarie referred to as *over a spring* was, in fact, the watercourse, the creek, of the natural spring on higher ground to the south-east, at Bent Street. The Macquarie Place Fountain operated much as did the Bent St Fountain, with people bringing their buckets to be

filled as a daily chore (it might be assumed that this chore was one performed by the servants or staff - a task so mundane as to be rarely mentioned in the writings of the educated classes).

As with the Bent Street fountain, the Macquarie Place fountain was made redundant when Busby's Bore brought fresh water into the city from 1826 onwards (as noted, the Bore was finally completed in 1837). In 1842, the Sydney Corporation was formed and, from 1844, pipes were laid throughout the town to distribute the water direct to houses and businesses. The public fountains became an amenity, rather than a necessity.

The Macquarie Place fountain was remodelled in 1862 to serve as a public drinking fountain. The arches were filled and a doorway installed in the main opening. Water faucets and bowls were added on one or two faces. In 1866, a proposal to demolish the Fountain was raised but: . . . *local residents asked that it be retained on the grounds of its great service, as an old relic and of its ornamental appearance.*¹¹ By the 1880s, the Macquarie Place fountain was dilapidated and it was demolished and replaced by a statue of Thomas Mort that remains today.



The Macquarie Place fountain appears in the foreground of this photograph of the Royal Exchange Building in circa 1863 by Dalton's Royal Photographic Establishment.

(Source: State Library of New South Wales; SPF/316).



The Macquarie Place Drinking Fountain in the 1870s.
Source: SLNSW.

8 *The Sydney Gazette and New South Wales Advertiser*, Saturday 18 March 1820; *Government and General Orders*.

9 *ibid.*; Saturday July 1820; *Government and General Orders*

10 John Thomas Bigge: *Report of The Commissioner of Inquiry into The State Of The Colony Of New South Wales*. 19 June 1822; Addendum B: Macquarie's Response; House of Commons UK.

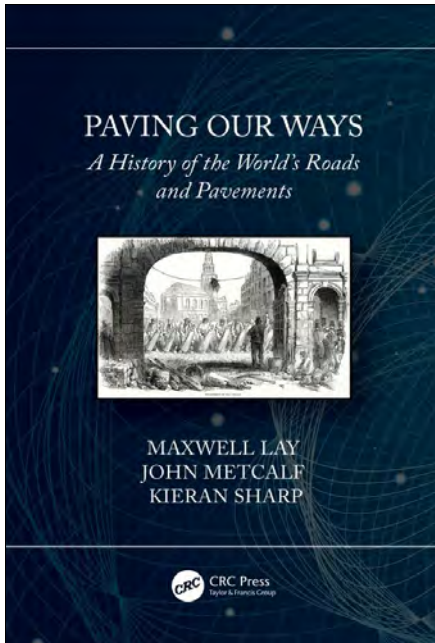
11 Council Correspondence, Letters 924 7 927; cited in Casey & Lowe; *The Obelisk, Macquarie Place - Conservation Issues Report* ; 2003.

PAVING OUR WAYS

A History of the World's Roads and Pavements

A book by Maxwell Lay, John Metcalf and Kieran Sharp, published by CRC Press.

A Review by Keith Baker.



Having reviewed Max Lay's eBook on 19th century transport, *With Power & Purpose*¹, for Engineering Heritage Australia Magazine in October 2016, I was asked by the editor to review the recent book on road pavements for which Max Lay was lead author. For an electrical engineer, the thought of digesting 22 chapters on roads was somewhat daunting, but having worked most of my engineering career in multi-discipline teams which included civil engineers covering construction and maintenance of roads, hardstand and airfield pavements, most of the terminology was familiar to me, if not the full technical understanding. So I accepted the challenge.

I found much of interest from a heritage perspective in the changing technology across the world from China and Mesopotamia, Europe, Britain, Australia and North America, stretching from biblical times to the present day. A striking aspect was the far from linear progression from the highly developed Roman roads to the impassable mud and slush of mediaeval English tracks, and the geographic, political and economic factors which either hindered or advanced the development of appropriate pavement technologies. Key issues were the availability of suitable materials and the variability of natural ground surfaces to be crossed. A less obvious factor was

the lack of national ownership and funding of roads, as they benefited the travellers who passed by but not necessarily the landowners or the labourers pressed to maintain them.

Until after the industrial revolution and apart from times of war, there was little interest from governments in funding roads beyond their immediate area of concern, and no national imperative. The Romans had the ability and motivation to build permanent roads as they extended their empire, but after their demise the technology and economic imperative was lost. Meanwhile horse drawn vehicles with narrow iron rimmed wheels turned the alternative dirt tracks to mud or ruts which seriously impeded the transport of people and goods. The disdain the general population had for roads in towns was shown by the widespread custom of throwing household rubbish from windows onto the street, while the lack of laws covering roads meant gravel or soil could be removed with impunity.

From a technical perspective, the book traces world progress in pavement development with numerous references to sources and cross referencing between chapters, and provides two tutorial chapters for non-engineers on basic concepts and materials. For example it describes the difference between gravel containing rounded stones and the sharp edges of crushed stone which allowed compaction, and the difference between tar, asphalt and bitumen and their use in 20th century roads.

Beginning with the importance of a sound base course which needed to be kept as dry as possible by proper contouring and drainage, the book describes different approaches by engineers such as Telford, using a base of large stones arranged flat or on edge, through to concrete, wood or well graded compacted crushed rock championed by McAdam, that continues to the present day. The wearing surface above the base course then served a dual purpose of waterproofing the base course and providing a suitable surface for wheeled vehicles and in earlier times the horses that pulled them.



Laying wood block paving on San Pietrini, Rome, c1910.

Photo courtesy Prof. Enrico Menduni.

¹ Subsequently published in hard cover as *The Harnessing of Power*, by Cambridge Scholars Publishing.

PAVING OUR WAYS – A Review by Keith Baker.

This was achieved with a layer of finer sharp rock compacted into the surface of the base course with the finest particles filling the gaps. This surface was capable of maintenance by adding more fine crushed stone to fill and compact the surface. Other techniques are also described which proved to be more expensive and less generally applicable, such as individually placed cobblestones, wood blocks, geometrically arranged stone setts, stone slabs and even cast iron square blocks.

An interesting factor in the change from unsealed Macadam to covering with a bitumen seal in the 20th Century was the advent of rubber tyres on higher speed motorised vehicles, which raised objectionable dust.



Stone setts on the Champs Elysees, Paris – photo by the authors.

The end chapters of the book concentrate on more recent design techniques and quality assurance, introducing both stress analysis and empirical design supported by international best practice. Design aspects discussed include not only the economic balance between capital cost, durability and maintenance of road pavements, but also the safety and traction on corners and the comfort of motorists related to the roughness of the road surface at a micro and macro level.

The book should provide a comprehensive reference for civil engineering students and practising engineers, and will be interesting from a history and heritage perspective for more general readers of the EHA Magazine.

Connections

Introduction to Heritage Engineering - new at Canberra University.



The University of Canberra is hosting the new course, created by Engineering Heritage Australia, and titled *Introduction to Heritage Engineering*. See something about the course at: <https://www.canberra.edu.au/ucpro/courses/introduction-to-heritage-engineering> *This course will provide engineers and other professionals with an introduction to the skills to assess significance and understand the conservation needs of engineering and industrial heritage sites and items.*

We had very short notice, because the course started on the 18th of May and enrolments closed on 17th May. However, it is assumed that the course will be an ongoing thing, so if you are interested, keep your ear to the ground for the next course.

The Archaeology of Craft and Industry and The Romance of Iron and Steel.

A couple of items from *LA on the Web* in a recent issue of the SIA Newsletter caught my attention. *The Archaeology of Craft and Industry*, is a webpage from the University of Illinois Urbana at: faculty.las.illinois.edu/cfennell/IndustrialArchaeologyBook.html From SIA: *This web page provides an extensive bibliography and list of internet resources related to industrial archaeology, based on a forthcoming book of the same title by Christopher Fennell.* And:

“The Romance of Iron and Steel” (digital.hagley.org/FILM_2018201_FC09). *The earliest print of a film in the Hagley collection. Produced in 1938 and sponsored by the American Rolling Mill Co. (ARMCO), the film explains the science and process of making rolled steel. The film opens with an overview of the ARMCO Research Lab and then follows the manufacturing process through the company’s production facility. Likely shot on location at ARMCO in Middletown, Ohio.*



Do You Love Me? from Boston Dynamics

And here is a bit of fun to finish up – compliments of my daughter Jessie, who is always a great source of web novelties: <https://www.youtube.com/watch?v=fn3KWM1kuAw>

Connections

A Reminder – Engineers’ Country Weekend at Nagambie, Victoria, in October. Save the Dates - 15, 16 & 17 October 2021.



This casual family weekend for Regional Engineers, Associates and friends will be held in Nagambie and will continue the successful format of previous weekends held throughout Country Victoria for past decades. The weekend will showcase Nagambie and the surrounding area including dinner on Saturday night (16th), plus a Heritage recognition ceremony at the Goulburn Weir (see photo at left) on Sunday morning (17th). An opt-out pre-weekend ‘meet-and-greet’ is available on Friday night (15th). For more information and a full program contact:

David Eltringham at djelt@bigpond.com 0418 147 482 or Martin Duke at fam_duke@yahoo.com 0458 788 747.

NSW Locomotive 3801 relaunched from 13-14 March 2021.

Following a decade-long restoration, Transport Heritage NSW is pleased to announce the return of locomotive 3801 – designed in the late 1930s and built in 1942. *Stand by for belching steam and shrieking whistles, with special rides departing from Central Station on Saturday 13 and Sunday 14 March 2021, followed by a program of day trips and shuttle ride weekends in regional NSW.* I am sorry this notice didn’t reach me until after the January issue of this Magazine was published – too late for the launch, and the country trips with 3801 that happened before this issue was published – but there will be opportunities later. You can probably find details on the Transport Heritage NSW website at <https://www.thnsw.com.au/3801> Also, have a look at <https://www.thnsw.com.au/post/nsw-governor-officially-relaunches-3801> This Transport Heritage NSW page also gives you access to *Historical Stories, Heritage & Collection Items, Restoration Projects and More*, with some fascinating information and stories.



Arches, an open-source software platform for cultural heritage data management.



Jenny Dickens of Heritage Victoria drew our attention to this website, produced by the Getty Conservation Institute. Jenny thought it looked interesting, and I agree with her. I thought some of our readers could find it very useful, particularly if they are thinking of establishing databases and web sites themselves.

Have a look at: https://www.getty.edu/conservation/our_projects/field_projects/arches/

Finding former EHA Newsletters

Some years ago, Engineers Australia removed all the EHA Newsletters from its website – or if they weren’t removed, they became phenomenally difficult to find. The first newsletter was published, on paper, in Spring 1992, and the last in October 2012. Ken McInnes found a web version of the first one on Trove at:

<https://webarchive.nla.gov.au/awa/19980204084032/http://ieaust.org.au/colleges/multi/heritage/newsletter.htm> but it didn’t seem to lead to any more. I do have a full (I hope) set of 26 PDFs, which I hope will be accepted by the NLA to go on Trove, along with some paper copies. If there are more than 26, please let me know. And as Helen Martin said – stay tuned for updates!



Detroit’s Revival Is Anchored in Its Train Station

I think my daughter sent me this link to a NYTimes story more than a year ago. It went astray during the bushfires but resurfaced recently, and is still worth a read. See: <https://www.nytimes.com/2020/01/21/business/detroit-ford-train-station.html>

2021 Australasian Engineering Heritage Conference.

Engineering New Zealand | te ao rangahau

The Future of the Past

In case you haven't heard about the Conference before, or you haven't yet decided whether or not to go, here is a reminder from Engineering New Zealand. With any luck, there will be a "travel bubble" still in place between Australia and New Zealand in November and the travel will be simple again. *The Editor.*

Join us in New Zealand's heritage-rich southern city of Dunedin for an action-packed four days of engineering heritage, including two full days of inspiring sessions and keynote speakers, and a post-conference half-day tour of Dunedin's most interesting engineering heritage sites.

The conference theme - The Future of the Past- focuses on heritage engineering and technology that has endured, been redeveloped, undergone restoration or repurposing to claim a place in the future.

Pre-conference tour: 11-14 November 2021

Conference: 14-17 November 2021

Registration opened on 10th May 2021

Pre-conference tour: Join us for a tour of southern New Zealand's best engineering heritage sites.

To whet your appetite ahead of the conference, experience a three-day pre-conference tour taking in the best of Southland's engineering heritage across Queenstown, Milford Sound, the South Coast and Invercargill.

Download a booklet with the full programme for the pre-conference tour from our website -

<https://www.engineeringnz.org/programmes/heritage/heritage-2021/>

We're delighted to announce our keynote speakers:

Takerei Norton (Ngai Tahu), Manager of the Ngai Tahu Archive and Ka Huru Manu, the Ngai Tahu Cultural Mapping Project, which focuses on recording Ngai Tahu histories, traditions, and place names on the Ngai Tahu Geographical Information System.

Keith Paterson, Project Director for the restoration of Christchurch Cathedral which was severely damaged and closed by the 2011 earthquakes.

Matthew Churchward, Curator for Museums Victoria and closely associated with the restoration of the Great Melbourne Telescope.

Glen Hazelton, Director Organisational Development, Heritage New Zealand Pouhere Taonga.

Read more about our keynote speakers on our website.

We look forward to seeing you in Dunedin!



And here are a few of the sights to take in as you travel around South Island on the pre-Conference Tour.

The Editor.

Images: Clockwise from Left --

The Invercargill Water Tower.

Photo: NZ History website.

Clifden Suspension Bridge.

Photo: Southland New Zealand website.

Exhibits at the Bill Richardson Transport World.

Photo: Must Do New Zealand website.



